Announcement n. 24141

DOE-INFN Summer Students Exchange Program 2022 Edition

The US Department of Energy (DOE) and the Istituto Nazionale di Fisica Nucleare of Italy (INFN) announce the 2022 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, 2022.

There are 11 positions available. Applicants can choose among 17 different INFN sites and 55 research projects.

Grants amount to 6000 € to cover travel and living expenses. They are subjected to a 30% reduction due to Italian income taxes.

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 2022.

Applications, in electronic form, must be sent to INFN not later than 30th March, 2022 (11.59 pm CEST) 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).

Roma, 28th February 2022

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.CMS1 Title:** Configuration of a HEP analysis workflow in a Jupyter environment with the aid of GooFit and PROOF-Lite tools
1.Bari	**2.CMS2 Title:** Test beam performance measurements of high-resolution micro-pattern gaseous detectors for the CMS experiment at HL-LHC and the Muon Collider experiment
1.Bari	**3.Fermi-LAT Title:** Gamma-ray analysis of transient sources at high energies
1.Bari	**4.LHCb Title:** Search for the flavour partners of the X(3872) meson
1.Bari	**5.MeV gamma-rays Title:** Characterization of a prototype detector for MeV gamma-rays
2.Cagliari	**6.DarkSide Title:** Simulation and data analysis in dark matter liquid argon detectors
2.Cagliari	**7.LHCb Title:** Studies of Heavy Nuclei collisions at LHCb
2.Cagliari	**8.CMS Title:** Higgs searches with the CMS experiment at CERN
3.Ferrara	**9.BESIII Title**: Realization of an interlock for the CGEM-IT detector
3.Ferrara	**10.BESIIICGEM Title**: Study of the planar GEM detector readout by TIGER electronics
3.Ferrara	**11.RD_FCC1 Title**: Study of IDEA muon tracker and preshower detector based on micro-RWELL technology
3.Ferrara	**12.RD_FCC2 Title**: B_s → D_s K and B_s → J/psi phi analyses: benchmark for flavor studies at future electronpositron colliders
4.Firenze	**13.CMS1 Title:** Precision measurements of the Higgs boson production in the WW decay channel with the CMS experiment at LHC
4.Firenze	**14.CMS2 Title:** Characterization of Si-pixel based detectors for CMS HL-LHC Upgrade
4.Firenze	**15.SQMS / SFT** (Superconducting Quantum Materials and Systems / Statistical Field Theory)**Title:** Quantum algorithms and simulation methods for noisy intermediate-scale quantum processors
5.Genova	**16.ATLAS Title:** Pixel Detector for the ATLAS Upgrade at HL-LHC
5.Genova	**17.DUNE Title:** Tests of detector prototype for imaging of particle tracks in liquid Argon
5.Genova	**18.JLAB12 Title:** Light Dark Matter searches at Jefferson Lab
5.Genova	**19.JLAB12 Title:** AI-supported analysis of CLAS and CLAS12 data
5.Genova	**20.Phenomenology and ATLAS Title:** Jet physics at the LHC
6.Lecce	**21.ATLAS Title:** Building the future of the ATLAS experiment with the ITk pixels
7.LNF-Frascati National Laboratory	**22.PADME Title:** Commissioning and calibration of the PADME electron tagger detector
7.LNF-Frascati National Laboratory	**23.SHERPA** (Slow Highefficiency Extraction from Ring Positron Accelerator) **Title:** SHERPA bent crystal data analysis
7.LNF-Frascati National Laboratory	**24.CYGNO Title:** LIME, zero prototype for Dark Matter search and Neutrino astronomy based on Time Projection Chamber optical read out.
7.LNF-Frascati National Laboratory	**25.SIDDHARTA-2 Title:** Kaonic atoms measurements at the DAFNE collider with the SIDDHARTA-2 experiment
7.LNF-Frascati National Laboratory	**26.VIP Title:** Tests of Quantum Mechanics within the VIP experiment: Pauli Exclusion principle and gravity related collapse models
7.LNF-Frascati National Laboratory	**27.SEY1 Title:** Determination of Surface Charging/Discharging Conditions by Secondary Electron Yield Investigations
7.LNF-Frascati National Laboratory	**28.SEY2 Title:** Investigation of a-C at cryogenic temperature by SEY
7.LNF-Frascati National Laboratory	**29.LHCb Title:** Semileptonic decays of the B_s meson, a tool for New Physics discovery
7.LNF-Frascati National Laboratory	**30.MITIQO Title**: Innovative ultra-high resolution X-ray spectrometer for liquid sources
7.LNF-Frascati National Laboratory	**31.NANOSENSORS Title:** Nanosensors for biomedical applications
7.LNF-Frascati National Laboratory	**32.ELECTRON BEAM ACCELERATION Title**: Electron beam acceleration for advanced materials characterization
7.LNF-Frascati National Laboratory	**33.NANOELECTROMAGNETICS Title:** NanoElectromagnetics (microwave/RF/photonics)
8.LNL-Legnaro National Laboratory	**34.AGATA Title:** New digital electronics for the AGATA array
8.LNL-Legnaro National Laboratory	**35.LARAMED Title:** Experimental and Numerical Study of Innovative Compact Heat Sinks made by Metal Additive Manufacturing in the Turbulent Subcooled Boiling Regime

INFN Sections and Laboratories	Research Projects
8.LNL-Legnaro National Laboratory	**36.PANDORA Title:** The PANDORA Project: reproducing a stellar environment in a Laboratory
8.LNL-Legnaro National Laboratory	**37.SiPM Titolo**: Getting used with a Silicon Photomultiplier (SiPM) to prepare the teaching material for high school student
9. LNS-South National Laboratory	**38.KM3NET Title:** Construction of the km3net high energy neutrino telescope at 3500 m depth offshore CapoPassero
9. LNS-South National Laboratory	**39.DUNE Title:** Study of the performance of a Near Detector for the DUNE experiment at FNAL (USA)
9. LNS-South National Laboratory	**40.FRAISE Title:** TAGGING SYSTEM LNS FRAGMENT SEPARATOR
9. LNS-South National Laboratory	**41.CHIRONE Title:** EXPERIMENTAL ACTIVITY IN NEUTRON DETECTION SIMULATION
10.Milano	**42.LHCb Title:** Commissioning of the UT detector
11.Padova	**43.QUAX Dark Matter Search:** Axion Haloscope
11.Padova	**44.CTA Title:** Analysis of climate data obtained from a Raman LIDAR for astronomical observation with CTA
11.Padova	**45.ICARUS – SBN TITLE:** Studies on the neutrino events collected in the ICARUS T600 detector at FERMILAB
11.Padova	**46.GAMMA – RIKEN Title:** Exclusive cross section measurement of 52Fe excited states populated via knockout reactions.
11.Padova	**47.LHCb2** ***Title:*** Efficient *b*- and *c*-jet identification at the LHCb experiment using quantum machine learning
11.Padova	**48.LHCb1** Title: Test of Lepton Flavour Universality with LHCb exploiting multivariate techniques
12.Pavia	**49.RF_FCC and HiDRa Title:** Dual Readout Calorimeter R&D for FCC
13.Pisa	**50.SWEATERS Title:** Characterization measurements of a gas detector based on bulk-MicroMegas technology for low energy ionizing particles of SWEATERS Project
13.Pisa	**51.VIRGO – ET Title:** Laboratory measurements campaign by using high precision and low noise sensors for future Gravitational Waves detectors
14.Roma	**52. ANDROMeDa**
15.Roma 2	**53.FastCaloGAN Title:** FastCaloGAN, a fast calorimeter simulation tool for ATLAS
16.Torino	**54.LUNA Title:** Characterization of an array of HPGe and scintillator detectors for low energy nuclear astrophysics at LUNA (Laboratory for Underground Nuclear Astrophysics)
17.Trieste	**55.ITS3 Title:** 65 nm CMOS test structures characterization

1. BARI

1. CMS1

Title: Configuration of a HEP analysis workflow in a Jupyter environment with the aid of GooFit and PROOF-Lite tools.

Description: In recent years, new technologies and new approaches have been developed in industry and academia to answer the necessity to both handle and visualize easily huge amounts of data, the so-called "big data". Good examples are the PANDAS framework, which is an open source set of data analysis tools allowing data structures building and fast manipulation, and the Jupyter Notebook, which is a web application that allows users to create and share documents that contain executable live code. The combination of these two technologies may result in a powerful and easy-to-use tool for a data analyst in the context of High Energy Physics.
A student working on this project will join the efforts of the CMS Bari B-Physics group and will help to configure, test and document a complete HEP analysis workflow in a Jupyter environment, eventually comparing it to a conventional ROOT-based workflow. A first step will involve the skimming, executed on multiple cores via PROOF-Lite, and conversion to PANDAS-like dataframes, through tools such as uproot, of the traditional ROOT dataset files. The second part will be completely developed within the Jupyter Notebook framework and will include data manipulation, feature extraction, visualization and interpolation. The last task, when the dataset population will require it, will be handled with the help of GooFit, a tool that exploits the computational capabilities of GPU to perform maximum likelihood fits.
As a physics application to carry out the project, we would like to extract, from the CMS Run-2 dataset, the signal associated with the rare decay Bc → Psi(2S) Pi where Psi(2S) is reconstructed in its decay to J/psi Pi Pi. We also expect a joint effort to document every step with a Twiki-based recipe that can be used in the future as material for teaching purposes as well.
The student should have a good background in Python programming. Some experience with C++ will be useful. Background in physics or statistics would also be useful. Our group is also in contact with a student association which arranges accommodation for visiting students and professors.

Further references:
https://jupyter.org
https://pandas.pydata.org
https://uproot.readthedocs.io/en/latest/
https://root.cern.ch/proof
https://pandas.pydata.org
https://github.com/GooFit/GooFit

Tutors:
Adriano Di Florio (adriano.diflorio@ba.infn.it)
Alexis Pompili (alexis.pompili@ba.infn.it)

Activity period: 2 months. June-July (highly preferred) or September-October

Local Secretariat: INFN BARI - Antonio Silvestri tonio.silvestri@ba.infn.it

Other information:

- https://www.ba.infn.it/index.php/it/
- Summer closure: 8-21 August
- Price range for a room/studio: 550-750€/month

1. BARI

2. CMS2

Title: Test beam performance measurements of high-resolution micro-pattern gaseous detectors for the CMS experiment at HL-LHC and the Muon Collider experiment.

Description:
Triple-GEM detectors are among the most advanced technology in micro-pattern gaseous detectors, able to cope with the strict requirements of space resolution and rate capability of present-generation high-energy physics experiments. An ongoing test beam campaign is aimed at measuring the performance of GEM detectors designed for the Phase-2 CMS upgrade and the Low Emittance Muon Accelerator (LEMMA) experiment, a proposed accelerator scheme for the Muon Collider.
The student will analyze the data collected during two test beam campaigns at CERN, to determine the efficiency and space and time resolution of the detectors with muons and pion. He/she will also participate in the preparation of the setup for the future test beams.
Requirements: modern programming language (C++, Python etc.) at a basic level, basic knowledge of the working principles of gaseous particle detectors, basic laboratory activity.
Outcome: the student will gain a deeper understanding and operational experience of GEM detectors. He/she will learn to work independently in the laboratory and in the experimental area.

Tutor:
Piet Verwilligen (piet.verwilligen@ba.infn.it)
Rosamaria Venditti (rosamaria.venditti@ba.infn.it)

Activity period: June- July

Local Secretariat: Antonio Silvestri, segreteria@ba.infn.it

Other information:

1. BARI

3. 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 13 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 analysed 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 analyse 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 2022 or September-October 2022

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

Other information: Institute will be closed August 8-21, 2022.

1. BARI

4. LHCb

Title: Search for the flavour partners of the X(3872) meson

Description: After almost 20 years the nature of the X(3872) is still unclear. Its properties challenges the potential models of the charmonium states and many authors have suggested that the X(3872) might be a state made of 4-quarks. A neat prediction of such scenario is the existence of flavour partners as for the conventional hadrons. The candidate will look for a charged partner and a strange partner of the X(3872) by analyzing data collected by the LHCb experiment.

Tutor: Pappagallo Marco

Activity period: June-July

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

1. BARI

5. MeV gamma-rays

Title: Characterization of a prototype detector for MeV gamma-rays

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. In this project, a prototype of an active converter module for the detection of MeV gamma-rays will be characterized. The prototype is made of thin scintillator crystals coupled to WLS fibers readout by Silicon Photomultipliers. The design allows the photon conversion through Compton scattering and the measurement of position and energy of the recoil electron.

Activities: The student will study the prototype detector, focusing on the characterization of the photosensors (SiPMs) and of the readout electronics. The student will learn the basics of data acquisition systems, using different programming languages, such as *python* and *LabVIEW*. The student will characterize the detectors with a particular focus to the readout electronics.

Tutor:
M.N.Mazziotta(marionicola.mazziotta@ba.infn.it),
L. Di Venere (leonardo.divenere@ba.infn.it)

Activity period: June-July 2022 or September-October 2022

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

Other information: Institute will be closed August 8-21, 2022.

2. CAGLIARI

6. DarkSide

Title: Simulation and data analysis in dark matter liquid argon detectors

Description: *Thanks to the last results from the experiments DarkSide-50, at LNGS, and DEAP-3600, at SNOLAB, liquid argon has showed to be an outstanding target for the dark matter search, specifically for masses below 10 GeV with DarkSide [1] and for heavier candidates with DEAP[2][3]. The student will have the opportunity to work on the dark matter search in DEAP-3600, together with the local researchers. Moreover, he/she will have the chance to see first hand the technology behind liquid argon, in the recently born lab of DarkSide local group.*
References:
[1] Phys. Rev. Lett. 121, 081307, P. Agnes et al. (DarkSide Collaboration), "Low-Mass Dark Matter Search with the DarkSide-50 Experiment"
[2]Phys. Rev. D 100, 022004,R. Ajaj et al. (DEAP Collaboration), "Search for dark matter with a 231-day exposure of liquid argon using DEAP-3600 at SNOLAB"
[3] Phys. Rev. Lett. 128, 011801, P. Adhikari et al. (DEAP Collaboration), "First Direct Detection Constraints on Planck-Scale Mass Dark Matter with Multiple-Scatter Signatures Using the DEAP-3600 Detector"

Activities: Data analysis - Simulation in RAT/GEANT4 - Programming in Python and ROOT/C++ - data acquisition

Tutor: Dr. Michela Lai (michela.lai@ca.infn.it)

Activity period: September -October

Local Secretariat: Progect Principal Investigator : Dr. Walter M. Bonivento (walter.bonivento@ca.infn.it) Segretariat : Maria Assunta Lecca (mariassunta.lecca@ca.infn.it)

Other information: The Department of Physics is open to students from Monday to Friday, 8 AM-8 PM. Due to the pandemic emergency, students are asked to be fully vaccinated to have access to the university. Below some useful links related to the activity: http://deap3600.ca
https://www.lngs.infn.it/it/darkside

Some accommodation shared with local students are usually available in September and October, with an average cost of 250 euros for one room in Cagliari city center. In this case, please get in contact with the tutor as soon as you know you will join us, so that she can help with your accomodation. Otherwise, a few other structures, close to the department:
https://www.airbnb.it/rooms/44240108?adults=1&location=Sestu%2C%20CA&check_in=2022-09-01&check_out=2022-09-30&display_extensions%5B0%5D=MONTHLY_STAYS&federated_search_id=fa5c1686-187b-4cfb-ac09-1c7db1d5d6b2&source_impression_id=p3_1642070008_1pQhHZQTu8F%2BFYIR&guests=1

https://www.airbnb.it/rooms/46251098?adults=1&location=Sestu%2C%20CA&check_in=2022-09-01&check_out=2022-09-30&display_extensions%5B0%5D=MONTHLY_STAYS&federated_search_id=69d8e631-5d3f-4f5d-8362-48e43f58dcc5&source_impression_id=p3_1642070374_noeMDS8Z4L8B17Aa&guests=1

2. CAGLIARI

7. LHCb

Title: Studies of Heavy Nuclei collisions at LHCb

Description: LHCb is one of the four LHC experiments which started operations in 2010 and it has collected more than 10 fb-1 of pp collisio
n data at several centre of mass energies. In addition to the pp run, LHCb has also operated during the LHC Heavy Ion run and has collected data both in pPb and PbPb collisions, the latter since 2015. It does as well run an innovative fixed target program recording collisions of proton and lead with noble gases like Argon, Neon, Helium. With its forward geometry optimised for the study of heavy-flavor production and decay, LHCb is an ideal position to complement the Quark Gluon Plasma studies performed in ALICE, ATLAS and CMS in this area. The candidate will be involved in the activities of the group with a truly international composition. She/he will prevalently study the production of quarkonia and open charm in the PbPb and pPb samples collected in 2015, 2016 and 2018, and could be involved in collectivity studies in these samples. The candidate will optimise the extraction of the signal yields and will correct it for the efficiencies she/he measured in the dedicated Monte Carlo samples. The ratio of different states could also be measured, which would gives crucial indications on the formation of Quark Gluon Plasma.
Tutor: Giulia Manca (giulia.manca@cern.ch)

Activity period: *June 1st - August 4th or September 5th - October 31st 2022.*

Local Secretariat:
Maria Grazia Dessi (Administration Office)
Maria Assunta Lecca (Personnel Office)
Phone +39-06-675 4985, 4901

Other information:
The INFN CA site will be closed around August 5th-25th 2022.
More information on accomodation can be found on the website dedicated to the project at www.ca.infn.it .

2. CAGLIARI

8. CMS

Title: Higgs searches with the CMS experiment at CERN

Description: CMS is a multipurpose particle detector installed along the Large Hadron Collider at the CERN laboratories in Geneva. Since 2016 it recorded data from proton proton collisions at center of mass energy of 13 TeV. Analysing this data will provide a better understanding of the Higgs boson, a particle discovered in 2012 [1]. Data observations deviating from theoretical predictions would lead to insights of new physics. An important part of the study of the Higgs boson is to determine whether it decays into quarks of the second generation, question still unanswered [2]. These decays are predicted to happen very rarely. The most promising channel to study them is the Higgs decay into charm quarks. CMS has already analysed and published the data collected during 2016 [3]. The candidate will analyse the large dataset of 137 fb-1 collected by CMS during Run2 (2016, 2017, and 2018). In this context they will collaborate with international experts from institutes of the CMS collaboration. The candidate will focus their research on the Higgs decay into charm quarks using VBF production mode. They will analyse CMS data learning how to use and optimise the most recent data analysis techniques and the latest machine learning and computing tools.
References:
[1] CMS Collaboration. "Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC." PLB 716 (2012) 30. CDS record: http://cds.cern.ch/record/1471016
[2] CMS Collaboration. "Combined measurements of Higgs boson couplings in proton-proton collisions at sqrt(s) = 13 TeV. EPJC 79 (2019) 421. CDS record: https://cds.cern.ch/record/2640611
[3] CMS Collaboration. "A search for the standard model Higgs boson decaying to charm quarks". JHEP 03 (2020) 131 . CDS record: https://cds.cern.ch/record/2703386
Activities: Data analysis - Simulation in RAT/GEANT4 - Programming in Python and ROOT/C++ - data acquisition

Tutor: Pierluigi Bortignon

Activity period: September -October

Local Secretariat: Maria Assunta Lecca (mariassunta.lecca@ca.infn.it)

Other information: The INFN CA site will be closed around August 5th-25th 2022.
More information on accomodation can be found on the website dedicated to the project at www.ca.infn.it .

3. FERRARA

9. BESIII

Title: Realization of an interlock for the CGEM-IT detector

Description: The CGEM (Cylindrical Gas Electron Multipliers) detector is the proposed solution for the upgrade of the inner tracker of the BESIII experiment to be installed in 2024. The detector is composed of three layers of cylindrical GEMs. It will deploy several innovations with respect to the state-of-art gas detector, with light composite materials to provide mechanical support, a dedicated ASIC with its full readout chain, and an innovative solution for signal reconstruction. While the construction process is in finalization, the first two layers are taking data in a laboratory at IHEP. In preparation for the full commissioning with cosmic rays, an interlock system has been proposed to allow continuous data taking, by monitoring HV, gas and cooling status parameters, electronics operation and environmental conditions. The system will be developed by means of a Controllino board, a commercial PLC based on Arduino.
The candidate will prepare the system, test it in Ferrara laboratories with planar prototypes, and then ship it to Beijing, where it will be used to monitor the operation of the first two layers. The candidate will learn which are the main activities concerning the operation of a High Energy Physics detector and understand how commercial solutions can be applied to research and it will directly contribute to the detector final operations.

Activity periods:
June-July or September-November

Available periods:
1 June - 31 July
23 September – 23 November

Tutors:
Ilaria Balossino (balossino@fe.infn.it)
Gianluigi Cibinetto (cibinett@fe.infn.it)

Contact person:
Giulio Mezzadri (gmezzadr@fe.infn.it)

Local secretariat:
Paola Fabbri (paola@fe.infn.it)

Additional Information:
Summer break: circa August 7 – 20
Housing: Camplus Darsena city, (400 m from the university campus)
Canteen open at lunch-time in Campus Polo Scientifico e Tecnologico

3. FERRARA

10. BESIIICGEM

Title: Study of the planar GEM detector readout by TIGER electronics

Description: Gas Electron Multipliers (GEMs) were invented by Sauli in 1997 and they belong to a new generation of gas detectors called Micro Pattern Gas Detector (MPGD). Thanks to their low discharge rate probability, fast response and high radiation tolerance, GEMs have become a reliable detector both for trigger and muon systems. In recent years, with the possibility to mold them in a cylindrical shape, GEMs can also be used as internal trackers, as exploited by KLOE collaboration. A new Cylindrical GEM detector is under developement for the BESIII experiment to operate as an innovative internal tracker for the spectrometer. A dedicated ASIC, called TIGER, has been designed to readout the GEMs. A cosmic ray stand has been instrumented with planar GEMs to test the performance of the detector with the innovative electronics and provide useful information to the cosmic stand operating with the final layers in Beijing.
The candidate will work in Ferrara to optimize the setup and study the data collected with the cosmic stand and during a test beam performed in July 2021. The aim of the work is to test the performance of the charge and time readout with the new electronics, and validate the parameters to run in an operation mode called "microTPC", where the drift gap is operated as a tiny time projection chamber. Later, they will also collaborate to the analysis of the cosmic data taken with the final cylindrical layers. They will learn to operate an innovative detector with the final electronics, and they will have the opportunity to interact with both detector and electronics experts.

Activity periods:
June-July or September-November

Available periods:
1 June - 31 July
23 September – 23 November

Tutors:
Gianluigi Cibinetto (cibinett@fe.infn.it)
Riccardo Farinelli (rfarinelli@fe.infn.it)
Stefano Gramigna (gramigna@fe.infn.it)

Referente segreteria locale:
Paola Fabbri (paola@fe.infn.it)

Contact person:
Giulio Mezzadri (gmezzadr@fe.infn.it)

Additional Information:
Summer break: circa August 7 – 20
Housing: Camplus Darsena city, (400 m from the university campus)
Canteen in Campus Polo Scientifico e Tecnologico

3 FERRARA

11. RD_FCC1

Title: Study of IDEA muon tracker and preshower detector based on micro-RWELL technology

Description: With the discovery of the Higgs Boson, the Standard Model of Particle Physics has reached its full completion. While many details will be unveiled at the LHC, a future electron-positron circular collider will be built in the 2040s to deepen our understanding of the Higgs boson and its coupling with the other fundamental particles, plus to search for new physics signals beyond the Standard Model. One of the proposed spectrometers is IDEA (Innovative Detector for Electron positron Accelerator), which will deploy a few innovative concepts: a drift chamber with cluster counting; a light solenoid inside a dual readout calorimeter; precise muon counters for the search of Long-Lived Particles, one of the possible candidate of new physics.
The IDEA muon detector, as well as the preshower, will be built with an innovative micro-pattern gas detector, called micro-RWELL. The optimization of the parameters, e.g. strip pitch, resistivity, as well the full simulation of the apparatus is ongoing with both hardware and software developments.
In Ferrara, a series of activities are ongoing: simulation with GEANT4, preparation of a cosmic stand, participation, and data analysis of a test beam. The candidate, based on their time of arrival, will work with the experts on one or more of these activities. He will get acquainted with the work behind the development of an innovative gas detector for future experiments.

Activity periods: June-July or September-November

Available periods:
1 June - 31 July
23 September – 23 November

Tutors:
Isabella Garzia (garzia@fe.infn.it)
Gianluigi Cibinetto (cibinett@fe.infn.it)

Contact person:
Giulio Mezzadri (gmezzadr@fe.infn.it)

Local secretariat:
Paola Fabbri (paola@fe.infn.it)

Additional Information:
Summer break: circa August 7 – 20
Housing: Camplus Darsena city, (400 m from the university campus)
Canteen in Campus Polo Scientifico e Tecnologico

3. FERRARA

12. RD_FCC2

Title: B_s → D_s K and B_s → J/psi phi analyses: benchmark for flavor studies at future electron-positron colliders

Description: The future circular electron-positron collider will take data starting from the early 2040s to shed new light on the Higgs boson physics and search for evidence for physics beyond the Standard Model. Before the start of the Higgs program, the IDEA detector, one of the proposed spectrometers for the new accelerator, will collect data at the Z boson peak, collecting roughly 10^12 Z bosons in four years. This can be the ideal environment to enrich our knowledge of the CKM matrix, and in particular, to better constrain the gamma angle, owing to a clean environment and quantum correlated B decays. To understand and optimize the detector performance, dedicated benchmark studies for flavor physics have started with fast simulations of the full detector.
The candidate will collaborate with the lead analyst of the B_s → D_s K benchmark channel and, based on their arrival, the candidate will work to either finalize this work or to start the second channel, B_s → J/psi phi. These two channels are crucial for the determination of the gamma angle of the CKM matrix. These studies will be performed in the official FCC framework. The candidate will learn how to generate and simulate the process, study the main backgrounds and report to the physics group to understand the impact of the vertex detector, the drift chamber, and the PID on the final performance of IDEA.

Activity periods:
June-July or September-November

Available periods:
1 June - 31 July
23 September – 23 November

Tutors:
Isabella Garzia (garzia@fe.infn.it)
Gianluigi Cibinetto (cibinett@fe.infn.it)
Marco Scodeggio (mscodegg@fe.infn.it)

Contact person:
Giulio Mezzadri (gmezzadr@fe.infn.it)

Local secretariat:
Paola Fabbri (paola@fe.infn.it)

Additional Information:
Summer break: circa August 7 – 20
Housing: Camplus Darsena city, (400 m from the university campus)
Canteen open at lunch-time in Campus Polo Scientifico e Tecnologico

4. FIRENZE

13. CMS1

Title: Precision measurements of the Higgs boson production in the WW decay channel with the CMS experiment at LHC

Description: The candidate will join one of the leading groups involved in studying the Higgs boson decay to a W boson pair in the CMS collaboration.
After the Higgs boson discovery announced by the CMS and ATLAS collaborations in 2012, the precision measurement of its properties has become one of the main priorities of the two experiments. The proton-proton collisions at a center-of-mass energy of 13 TeV delivered during the Run 2 of the CERN Large Hadron Collider (LHC) allowed the collection of a large data sample, which opened new frontiers to study the details of Higgs boson physics and represented a change of paradigm: from seeking the Higgs boson to performing precision measurements. These are key measurements to expand our knowledge of the Higgs boson sector and to search for new physics that could show up in any deviation with respect to the Standard Model predictions.
Among the Higgs boson decay channels, the one to a W boson pair (H→WW) followed by the leptonic W boson decays is characterized by a large branching ratio and a good signal sensitivity, besides the significant contamination of background processes sharing a similar final state. These features make the H→WW channel the perfect candidate for a precision measurement.
The Summer Exchange Program project will focus on the development of a novel approach extensively based on the usage of deep neural network techniques, with the goal of isolating the H→WW signal and improving the background rejection.

Activities: Within the the CMS group of Firenze, the student will learn the basics of the statistical data analysis in the context of the H→WW measurements, as well as the tools to set up and optimize neural network based algorithms. The ideal candidate should have a basic knowledge of programming and python scripting.

Tutor: Lorenzo Viliani lorenzo.viliani@fi.infn.it

Activity period: June-July or September-October

Local Secretariat: sig.ra Antonella Pagliai, antonella.pagliai@fi.infn.it, 055.4572074

Other information: INFN Firenze summer closure mid-August, http://www.fi.infn.it

4. FIRENZE

14. CMS2

Title: Characterization of Si-pixel based detectors for CMS HL-LHC Upgrade

Description: You will join the development of cutting-edge technologies for upcoming particle physics experiments at HL-LHC.
The LHC machine, by which the Higgs boson has been unveiled, will be enhanced to boost the instantaneous luminosity up to 5-7.5×10^{34} $cm^{-2}s^{-1}$. This High Luminosity LHC program, HL-LHC, due to start in 2027, aims to reach integrated luminosities of 3000-4000 fb^{-1} over about a decade. To cope with this extreme scenario, CMS, one of the LHC experiments, will be substantially upgraded before starting the HL-LHC, a plan known as CMS Phase-2 upgrade. In particular the entire CMS Tracker will be rebuilt. The new apparatus will feature increased radiation hardness, higher granularity and capability to handle higher data rate and longer trigger latency.
The *Summer Exchange Program* project consists of participating to the extensive R&D program put in place to identify the Si-pixel detector suitable for instrumenting the innermost part of the new CMS Tracker. The current stage of the activity features 2- or 4-chips detector modules equipped with planar- and 3D- pixel sensors and prototype ASICs; these modules need to be characterized with respect to radiation hardness, efficiency, charge collection, spatial resolution, etc.

Activities: Within the CMS group in the INFN Firenze lab, you will learn how to use the FPGA-based data acquisition system to measure detector basic parameters and performance, configure testing procedures via python scripting and analyze results.

Tutor: Antonio Cassese, antonio.cassese@fi.infn.it

Activity period: June-July or September-October

Local Secretariat: sig.ra Antonella Pagliai, antonella.pagliai@fi.infn.it, 055.4572074

Other information: INFN Firenze summer closure mid-August, http://www.fi.infn.it

4. FIRENZE

15. SQMS / SFT (Superconducting Quantum Materials and Systems / Statistical Field Theory)

Title: Quantum algorithms and simulation methods for noisy intermediate-scale quantum processors

Description: This activity sets in the framework of the DOE project "Superconducting Quantum Materials and Systems", to which INFN takes part as the only European partner. SQMS has two main goals: develop quantum devices based on a combination of superconducting RF cavities and trasmons, and develop detection technologies for quantum states of very-low energy for applications in experimental fundamental physics. The INFN – Sezione di Firenze takes part to the project contributing to the theoretical work of the "Algorithms and Simulation" thrust. In particular, the research group involved will study new quantum algorithms and quantum simulation methods, specifically designed for current noisy intermediate scale quantum processors. Researchers of the group have theoretical expertise on benchmarking and programming such processors, possibly with hybrid quantum-classical procedures. They have studied how to map relevant problems of practical interest, such as combinatorial optimization problems or problems arising in material science or chemistry, into operations that can be performed in superconducting gate-based quantum computers or (Gaussian) boson sampling devices. The student who will possibly join the group will study how to tackle the unavoidable noise of these devices and help improving the available algorithms using feedback from probabilistic quantum-measurement outcomes. She/He might also take part to the design of new simulation methods to study non-equilibrium quantum effects with transmon devices, directly using the hardware to estimate low-energy excited states of quantum many-body systems. Finally, the student is welcome to participate in activities related to the SQMS project, or anyway of interest, that will possibly take place at the INFN Galileo Galilei Institute for Theoretical Physics during her/his time in Firenze.

Further references:
https://sqms.fnal.gov/
https://home.infn.it/newsletter-eu/pdf/NEWSL_INFN_75_ing_2.pdf
https://www.ggi.infn.it

Tutors:
Leonardo Banchi leonardo.banchi@unifi.it
Alessandro Cuccoli cuccoli@fi.infn.it
Laura Gentini laura.gentini@unifi.it
Paola Verrucchi verrucchi@fi.infn.it

Recommended period: June-July or September-October (one of the Tutors will always be available).

Other information: INFN Sezione di Firenze and GGI will be mainly closed during the first three weeks of August. Budget accommodations might be made available via our organization.

Local Secreteriat:
Antonella Pagliai antonella.pagliai@fi.infn.it

5.GENOVA

16. 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 in 2025 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 semiconductor 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 since 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, and the production of the forward support structures and their electrical services.

Activities: The student will have a chance to participate to the tests of 3D modules, the development of the system test for the electrical qualification of several modules on a support structure; the optimization of the mechanical and thermal qualification of the supporting structures.

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

5. GENOVA

17. DUNE

Title: Tests of detector prototype for imaging of particle tracks in liquid Argon

Description: A small prototype for imaging of particle tracks in liquid Argon by means of the scintillating light is currently under design. The first prototype will be tested in a simple set up already under construction in our laboratory. The apparatus is made by a light source with different wavelengths, a lens optical system and a light sensitive detector. Firstly some tests of the prototype will be performed in water, by using a Charge Couple Device (CCD) and visible light source and then in liquid Argon inside a cryostat, by using a vacuum ultraviolet light source and a small matrix of Silicon Photomultipliers. The student will perform tests for evaluating the performances of the optical system for light of different wavelengths and in different liquids and for comparing the results with the simulations.

Tutor: Lea Di Noto (lea.dinoto@ge.infn.it)

Activity period: 1 giugno – 30 luglio

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

Other information: Altre informazioni - sito web locale: www.ge.infn.it

5. GENOVA

. JLAB12

18. JLAB12 Title: Light Dark Matter searches at Jefferson Lab
19. **JLAB12 Title:** AI-supported analysis of CLAS and CLAS12 data

Description: The JLAB12 experiment includes all INFN-Italy activity at Jefferson Lab (USA). The Genova Group is deeply involved in the hadron spectroscopy program of the CLAS and CLAS12 experiments, aiming at studying multipion production, and in novel searches for light dark matter produced in accelerator-based experiments.

- Precision data collected with the CLAS and CLAS12 detectors are providing new insight in hadron structure and spectrum. To exploit the large statistics of the CLAS/CLAS12 data and extract the information preserving correlations between variables of measured particles, new methodologies are under study. In particular, the use of AI/ML already demonstrated to be a powerful tool to learn about subtle features of the data, providing a completely new way to extract the physics information. In collaboration with the JLab Theory Group and ODU Data Science Dept. we developed a new method based on Generative Adversarial Networks (GANs) to reproduce and interpret CLAS and CLAS12 spectroscopy (2pi photoproduction) and SIDIS (single pion semi-inclusive DIS) data. The student will learn the methodology and join the ongoing effort to extend the method to other reaction channels.
- Search for physics beyond the Standard Model can be carried out with high precision experiments in the GeV energy range. Failure in direct observation of Dark Matter in the 10 GeV – 10 TeV mass range suggests extending the hunting territory at lower masses (1 MeV - 1 GeV), opening up new opportunities for accelerator-based experiments. Light dark matter fermions and bosons, carriers of a new interaction, are actively searched for in several experiments running at Jefferson Lab (APEX, HPS, BDX, Dark Light ...). The Genova Group is leading the R&D program for the new Beam Dump eXperiment (BDX) which is being proposed at Jefferson Lab as new facility for light dark matter search. We are currently optimizing the design of the experimental setup to prepare the experiment. The student will work on simulations and detector tests in the Genova Lab.

Within these frameworks we can provide two summer-student activities, one related to the Meson-Ex experiment and the other on Light Dark matter search. For further information see:

Tutor: Marco Battaglieri (marco.battaglieri@ge.infn.it), Raffaella De Vita (devita@ge.infn.it)

Activity period: June – July or September – October

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

Other information: www.jlab.org/Hall-B/clas12/ and www.ge.infn.it

5. GENOVA

20. Phenomenology and ATLAS

Title: Jet physics at the LHC

Description: Because of its unprecedentedly high colliding energy, the LHC has reached energy scales far above the elecroweak scale. Therefore, analyses and searching strategies developed for earlier colliders, in which electroweak-scale particles were produced with small velocity, had to be fundamentally reconsidered. In particular, in the context of jet-related studies, the large boost of these objects (W/Z bosons, the Higgs bosons, top quarks or any new particle with a mass of the order of the electroweak scale) causes their hadronic decays to become collimated inside a single jet. This is particularly important in the context of Higgs physics, because its dominant decay channel is into jets, which suffers from a huge QCD background. Consequently, jet substructure studies have emerged as an important tool for searches at the LHC. In this research project the student will perform phenomenological studies of jet substructure observables exploiting both Monte Carlo simulations and analytic calculations.

Tutor: Simone Marzani (simone.marzani@ge.infn.it), Federico Sforza (fsforza@cern.ch)

Activity period: settembre-ottobre (Specifica delle date disponibili per il tutor 7 settembre- 7 novembre)

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

Other information: Altre informazioni- sito web locale: www.ge.infn.it

6. LECCE

21. ATLAS

Title: Building the future of the ATLAS experiment with the ITk pixels

Description: In order to face the harsh environment of the High-Luminosity LHC era, the ATLAS detector will upgrade the current Inner Dector (ID), consisting of silicon pixel, silicon strip detectors and Transition Radiation Tracker, with an all-silicon Inner Tracker (ITk), which has 13m2 of pixel detectors with 5 billion readout channels and 160 m2 of strip detectors with 50 million readout channels. Different components of the ITk detector are built and mounted together in different construction sites. Lecce group oversees the assembly of the pixel modules on a carbon fibers mechanical support (called Half-Ring), with a precision of few tens of microns. Prior to the assembly, the functionality of each module will be assessed with a dedicated data acquisition (DAQ) system and several metrology checks will be performed on modules and Half-Ring using a semi-automated gantry system. Depending on the personal preferences of the candidate and/or on the needs of the group, the candidate will mainly focus his activity on the DAQ or metrology checks.

Activities: Attività (optional)

Tutor: Luigi Longo (luigi.longo@le.infn.it / luigi.longo@cern.ch)

Activity period: giugno-luglio

Local Secretariat: carla.gentile@le.infn.it

Other information:
summer closing period: 5-28 August 2022

7.LNF – FRASCATI NATIONAL LABORATORY

22.PADME

Title: Commissioning and calibration of the PADME electron tagger detector

Description: In recent times, studying the de-excitation via electron-positron pairs production of some nuclear systems, a research group based at the ATOMKI of Debrecem has observed an anomaly that can be explained postulating the existence of a proto-phobic boson of mass 17 MeV (X17). The Positron Annihilation into Dark Matter Experiment (PADME) was approved to search for invisible decays of a dark photon produced in the process e^+e^- -> gamma A', with the A' undetected. By changing the energy of the incoming beam PADME can try to produce resonantly the X17 boson.
The measurement requires the determination of the 4-momentum of the e^+e^- pairs resulting from the decay of this hypothetical new particle and the rejection of all possible source of background. To perform such a measurement the PADME collaboration is building a new electron tagger that will be placed in front of the e.m. calorimeter. For more information visit: http://padme.lnf.infn.it/

Activities: The candidate will participate in the data taking for the commissioning of the new detector and in the analysis of the data for its calibration.

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

Activity period: September-October 2022

Local Exchange Program Contacts (DOE/INFN):
Paola Gianotti (coordinator)
E-mail: paola.gianotti@lnf.infn.it
Maria Cristina D'Amato (secretary)
E-mail: maria.cristina.damato@lnf.infn.it
Phone +39-06-94038133

Other information
- Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 8-19 August 2022.
- Local web page: http://user.lnf.infn.it/summer-student-opportunities/

7. LNF - FRASCATI NATIONAL LABORATORY

23. SHERPA (Slow Highefficiency Extraction from Ring Positron Accelerator)

Title: SHERPA bent crystal data analysis

Description: Characterization of bent silicon crystals studied for slow extraction of positrons and electrons from one of the DAFNE rings.

Activities: Data analysis of the measurements performed at the BTF-2 beam line to characterize beam deflection properties of the silicon bent crystals. The data will be acquired by a 2D silicon detector (TimePix3) and the main observables to be extrapolated are deflection angle and efficiency of each bent crystal.

Tutor: Marco Garattini (SHERPA P.I.) (marco.garattini@lnf.infn.it)

Activity period: June-July or September-October 2022

Local Exchange Program Contacts (DOE/INFN):
Paola Gianotti (coordinator)
E-mail: paola.gianotti@lnf.infn.it
Maria Cristina D'Amato (secretary)
E-mail: maria.cristina.damato@lnf.infn.it
Phone +39-06-94038133

Other information
- Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
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7. LNF - FRASCATI NATIONAL LABORATORY

24. CYGNO

Title: LIME, zero prototype for Dark Matter search and Neutrino astronomy based on Time Projection Chamber optical read out.

Description: LIME is the first prototype of the CYGNO experiment (https://web.infn.it/cygnus/) dedicated to the development of a large gas Time Projection Chamber with optical read-out dedicated to the search of dark matter and the study of solar neutrinos. LIME has been installed at the LNGS of the INFN and is going to start the collection of the first data.
After a phase dedicated to the commissioning of the detector and auxiliary systems (DAQ, gas system, LV / HV, PMT etc.), a calibration campaign and data collection is started, evaluating resolutions, efficiencies, pileup, etc. and the radioactive background of LNGS in different experimental configurations.

Activities: The candidate will be included in the R&D activity of the LNF group by participating in the laboratory tests and in the implementation of the experimental setup, calibration and data taking from the LNGS.

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

Activity period: June-July or September-October 2022

Local Exchange Program Contacts (DOE/INFN):
Paola Gianotti (coordinator)
E-mail: paola.gianotti@lnf.infn.it
Maria Cristina D'Amato (secretary)
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Other information
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- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 8-19 August 2022.
- Local web page: http://user.lnf.infn.it/summer-student-opportunities/

7. LNF - FRASCATI NATIONAL LABORATORY

25. SIDDHARTA-2

Title: Kaonic atoms measurements at the DAFNE collider with the SIDDHARTA-2 experiment

Description: SIDDHARTA-2 experiment aims to perform the first measurement in the world of the X-ray transitions in the kaonic deuterium exotic atom, which will help to understand the strong interaction described by the Quantum ChromoDynamics (QCD) theory in the non-perturbative regime in systems with "strangeness" (i.e. with strange quarks). The SIDDHARTA-2 experiment will measure the X rays produced in the de-excitations of kaonic deuterium by using new Silicon Drift Detectors developed to perform precision X-ray spectroscopy and which can have applications going from physics and astrophysics to industry and medicine. SIDDHARTA-2 is installed on DAFNE, an electron-positron collider delivering kaons, and will be in data taking through all 2022; a very exciting period for a student! The kaonic deuterium measurement plays a fundamental role in understanding how QCD works, with implications going from particle and nuclear physics to astrophysics (equation of state of neutron stars).

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

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

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

Activity Period: September – October 2022

Local Exchange Program Contacts (DOE/INFN):
Paola Gianotti (coordinator)
E-mail: paola.gianotti@lnf.infn.it
Maria Cristina D'Amato (secretary)
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Phone +39-06-94038133

Other information
- Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 8-19 August 2022.
- Local web page: http://user.lnf.infn.it/summer-student-opportunities/

7. LNF - FRASCATI NATIONAL LABORATORY

26. VIP

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

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

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

References: Underground test of gravity-related wave function collapse, A. Donadi et al., Nature Physics volume 17, pages 74–78 (2021) and Test of the Pauli Exclusion Principle in the VIP-2 Underground Experiment, C. Curceanu et al., Entropy 2017, 19(7), 300.

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

Activity Period: September – October 2022

Local Exchange Program Contacts (DOE/INFN):
Paola Gianotti (coordinator)
E-mail: paola.gianotti@lnf.infn.it
Maria Cristina D'Amato (secretary)
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Phone +39-06-94038133

Other information
- Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 8-19 August 2022.
- Local web page: http://user.lnf.infn.it/summer-student-opportunities/

7. LNF - FRASCATI NATIONAL LABORATORY

27. EY1

Title: Determination of Surface Charging/Discharging Conditions by Secondary Electron Yield Investigations

Description: Electrostatic charge forming on the Gravitational Wave (GW) mirrors severely affects detection sensitivity. At LIGO, a charging mitigation method has been successfully applied. This requires long mirror's exposures to a relatively high pressure of N_2 ions flux. It is impossible to apply this method when mirrors are at cryogenic temperatures, since a significantly thick condensed gas layer will develop on the mirror surface severely affecting its performance. An intense effort needs to be devoted to find new charging neutralization methods compliant with the constraints derived by the use of cryogenic optics. A possibility is given by selected energy electrons (between 10 to 100 eV) which, at very low doses, can impinge on the surface mirror. It is known, indeed, that according to their energy, the Secondary Electron Yield (SEY, which is the number of electrons emitted per incident ones) could be ≤ 1 or ≥ 1, i.e. removing or adding electrons at will on the mirror's dielectric surface. Even if conceptually simple, the actual refinement of this method and its implementation are a challenge. A first mandatory step is to know how much electronic charge is delivered (or removed) as a function of dose and energy of the impinging electron flux in realistic small samples, representative of materials composing the mirrors. This project aims to address this issue by using all the surface science spectroscopies available in the laboratory to first determine the SEY of mirrors samples in neutral and unperturbed conditions. After identifying and checking a measurement technique to quantify the surface charge, the goal is to define the electron beam parameters to induce on purpose charging/discharging on surface.

Activities: Laboratory and data analysis activity

Tutors:
Luisa Spallino (luisa.spallino@lnf.infn.it)
Marco Angelucci (marco.angelucci@lnf.infn.it)
Roberto Cimino (roberto.cimino@lnf.infn.it)

Activity period: June-July or-September-October 2022

Local Exchange Program Contacts (DOE/INFN):
Paola Gianotti (coordinator)
E-mail: paola.gianotti@lnf.infn.it
Maria Cristina D'Amato (secretary)
E-mail: maria.cristina.damato@lnf.infn.it
Phone +39-06-94038133

Other information
- Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 8-19 August 2022.
- Local web page: http://user.lnf.infn.it/summer-student-opportunities/

7. LNF - FRASCATI NATIONAL LABORATORY

SEY2

Title: Investigation of a-C at cryogenic temperature by SEY

Description: Electron cloud is a serious issue for most performing proton beam like the ones at LHC and for the planned Electron-Ion Collider (EIC). Electrons, produced by ionization of the residual gas by the passage of short spaced high-intensity bunches, can be accelerated toward the vacuum chamber walls by the proton beam, thereby releasing more electrons from the walls. This can create an electron avalanche that builds up rapidly in the beam vacuum chamber (that is electron cloud), thus causing detrimental effects (heat load, gas desorption, vacuum degradation, …) that gives rise to beam instabilities.
The key parameter governing the electron cloud formation is the Secondary Electron Yield (SEY, which is the number of electrons emitted per incident one) of the vacuum chamber material. To prevent electron cloud buildup, the choice of the material of the vacuum chamber surfaces is then crucial and a SEY close to (or below) 1 is needed. SEY is an intrinsic material property, highly sensitive to surface modifications. Then, when working at cryogenic temperature, the physisorption of residual gas species in the vacuum system may strongly affect SEY characteristics, especially in the low energy region of the spectrum.
It is known that an amorphous carbon (a-C) layer on Cu substrate can reduce SEY down to a value ~1. It is also known that this reduction may depend on the specific way a-C is grown, eventual presence of contaminants during its growth etc. Therefore, an experimental campaign could be launched to verify the SEY dependance upon growing parameters. This may be a crucial issue to validate an industrial production as the one planned for the Cu plated screen coated with a-C t to be installed in the RICH superconductive magnets. Validation should occur also at the low temperatures in which such materials will operate, since the chemical, structural and morphological characteristics of the a-C coating may be different at Low temperature.
This project aims to investigate the effects induced by the cryogenic conditions on the SEY of a-C coatings grown by various type of deposition of a-C on Cu. By using all the surface science spectroscopies available in the laboratory (SEY, XPS, RGA), electron irradiation will be also performed to investigate the modifications during operation (if any) of the relevant parameters of the different samples.

Activities: Laboratory and data analysis activity

Tutors:
Luisa Spallino (luisa.spallino@lnf.infn.it)
Marco Angelucci (marco.angelucci@lnf.infn.it)
Roberto Cimino (roberto.cimino@lnf.infn.it)

Activity period: June-July or-September-October 2022

Local Exchange Program Contacts (DOE/INFN):
Paola Gianotti (coordinator)
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Maria Cristina D'Amato (secretary)
E-mail: maria.cristina.damato@lnf.infn.it
Phone +39-06-94038133

Other information

- Accommodation: students may be accommodated, free of charge, in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 8-19 August 2022.
- Local web page: http://user.lnf.infn.it/summer-student-opportunities/

7. LNF - FRASCATI NATIONAL LABORATORY

29. LHCb

Title: Semileptonic decays of the B_s meson, a tool for New Physics discovery

Description: LHCb is one of the main experiment collecting data at the Large Hadron Collider accelerator. One of its primary goal is to study with high accuracy the properties of b-hadrons that are copiously produced in the proton-proton collisions at LHC. Measurements performed at B-Factories and LHCb, show an hint of violation of Lepton Flavour Universality (LFU) from the comparison of the B —> D(*) tau nu_tau (semi-tauonic) and B —> D(*) mu nu_mu (semi-muonic) decay widths. If these hints would be confirmed by other measurements, it will clearly be a sign of Physics Beyond the Standard Model. It is of paramount importance to study semi-tauonic decays in other b-hadron species both to check the presence of large LFU violation in alternative environments. The LHCb group in Frascati is deeply involved in the study of semileptonic decays of B_s mesons. The B_s mesons (containing an anti-b quark and a s-quark instead of a u- or d-quark, as in ordinary B meson) are interesting because have various advantages compared with the B mesons. A crucial one is that they allow to overcome some important source of backgrounds that affects the semitauonic decays of the B mesons. Moreover, semileptonic B_s decays offer many interesting kinematic observables that can be exploited to constrain various plausible New Physics scenarios.

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

- the developments of novel algorithms to control the soft photon efficiency, which is required by some of the measurements we are interested in;
- the optimisation based of signal selection and the study of a suitable sample to control the most dangerous backgrounds;
- the improvements of the resolution of the signal kinematic useful for precise measurements of some observables using Machine Learning.

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

Tutors: Marcello Rotondo (marcello.rotondo@lnf.infn.it)
Barbara Sciascia (barbara.sciascia@lnf.infn.it)

Activity period: 1 June - 5 August, 1 September - 28 October 2022

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7. LNF - FRASCATI NATIONAL LABORATORY

30. MITIQO

Title: Innovative ultra-high resolution X-ray spectrometer for liquid sources

Description: Bragg spectrometers are widely used in physics to perform extreme precision measurements of X-rays emitted from various types of sources. Among all their possible applications, measurements of metals in liquids, as well as the identification of their oxidation states, could be extremely useful for food quality checks.
The MITIQO collaboration, at the INFN Laboratories of Frascati, is realizing a Von Hamos spectrometer which, exploiting the high reflectivity and efficiency of mosai crystals based on graphite, aims to measure iron oxidation states in wine as well as the relative concentrations of many other elements.

Activities: Students involved in these activities will have the opportunity to work on the experimental setup, to perform several measurements as well as to learn the basic principles of X-ray spectroscopy and of statistical data analysis.

Tutor: Alessandro Scordo (alessandro.scordo@lnf.infn.it)

Activity period: September – October 2022

Local Exchange Program Contacts (DOE/INFN):
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7. LNF - FRASCATI NATIONAL LABORATORY

31. NANOSENSORS

Title: Nanosensors for biomedical applications

Description: Electrochemical DNA – sensors are one of the most promising tools with very diverse areas of application such as medical diagnostics, environmental pollutants monitoring, biological weapons defence etc. In spite of DNA – sensors already widely used in practice, they have a perspective for the improvement of functionality and cost – effectivity. One of the important directions in this matter is the increasing selectivity and sensitivity of sensors in expense of enhancement of electric signal and target – probe hybridization stability. Another important direction is the improvement of the electrode effectivity and manufacturability. From this point of view the best choice is the polymer – CNT enhanced nanocomposites, combining these two important features. At the same time, the better understanding of molecular mechanisms behind the DNA and RNA hybridization on the surface of electric transducer, and polymer – CNT nanocomposites formation is relevant for the improvement of effectivity and manufacturability of DNA – sensors**.**

Activities: the Student will carry out all-round activity in nanoscience, with a specific calling for technological applications, stemming from scientific achievements and with the help of a careful theoretical research and modeling activity.
The Student will also participate to the realization of the Nanomaterial (e.g. carbon nanotubes and graphene) that are synthesized in the nanotechnology laboratory, and the corresponding biosensor nano-devices, which he will subsequently characterize and test. The student will engage in the Chemical Vapour Deposition of carbon nanotubes (CNT) and Graphene on catalytic substrates and/or in porous templates, as well as in the arc discharge synthesis of carbon nanotubes, without impurities and with a low density of defects. Purification and functionalization of carbon nanotubes are carried out by LNF team by physical and chemical methods.

Tutor: Stefano Bellucci (bellucci@lnf.infn.it).

Activity period: June-July or September-October 2022**.**

Main references:
1. "Biological interactions of carbon-based nanomaterials: From coronation to degradation" Kunal Bhattacharya, Sourav P Mukherjee, Audrey Gallud, Seth C Burkert, Silvia Bistarelli, Stefano Bellucci, Massimo Bottini, Alexander Star, Bengt Fadeel, Nanomedicine: Nanotechnology, Biology and Medicine, Available online 17 December 2015
2. "Multiwalled carbon nanotube buckypaper induces cell cycle arrest and apoptosis in human leukemia cell lines through modulation of AKT and MAPK signaling pathways", Simona Dinicola, Maria Grazia Masiello, Sara Proietti, Pierpaolo Coluccia, Gianmarco Fabrizi, Alessandro Palombo, Federico Micciulla, Silvia Bistarelli, Giulia Ricci, Angela Catizone, Giorgio De Toma, Mariano Bizzarri, Stefano Bellucci, Alessandra Cucina, Toxicology in Vitro 7 (2015) 1298-1308
3. "Collapse and hybridization of RNA: View from replica technique approach", Y Sh Mamasakhlisov, S Bellucci, Shura Hayryan, H Caturyan, Z Grigoryan, Chin-Kun Hu, The European Physical Journal E 38 (2015) 1-9.
4. "Growth inhibition, cell-cycle alteration and apoptosis in stimulated human peripheral blood lymphocytes by multiwalled carbon nanotube buckypaper", O Zeni, A Sannino, S Romeo, F Micciulla, S Bellucci, MR Scarfi, Nanomedicine 10 (2015), 351-360

5. "Differences in cytotoxic, genotoxic, and inflammatory response of bronchial and alveolar human lung epithelial cells to pristine and COOH-functionalized multiwalled carbon nanotubes", Cinzia Lucia Ursini, Delia Cavallo, Anna Maria Fresegna, Aureliano Ciervo, Raffaele Maiello, Giuliana Buresti, Stefano Casciardi, Stefano Bellucci, Sergio Iavicoli, BioMed Research International,Volume 2014 (2014), Article ID 359506, 14 pages
6. "Targeted Nanodrugs for Cancer Therapy: Prospects and Challenges", Massimo Bottini, Cristiano Sacchetti, Antonio Pietroiusti, Stefano Bellucci, Andrea Magrini, Nicola Rosato, Nunzio Bottini, J. Nanosci. Nanotechnol 14 (2014) 98-114

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7. LNF - FRASCATI NATIONAL LABORATORY

32. ELECTRON BEAM ACCELERATION

Title: Electron beam acceleration for advanced materials characterization

Description: With the advent of the era of graphene, the universally famous two-dimensional allotrope of carbon, with its lightweight, amazing strength and unsurpassed ability to conduct electricity and heat better than any other material, previously unconceivable technological opportunities are opening up in a manifold of various applicative areas, in the true spirit of enabling technologies. The use of graphene can be envisaged in nanoelectronics, as a promising alternative to customary materials such as copper, which show well-known limitations in their utilization at the nanometer scale, owing to the challenges of dealing with higher values of frequencies and smaller sizes in beyond state-of-the-art applications. Features like tunable electronic properties may be exploited to realize, for instance, a microwave electronically tunable microstrip attenuator. Electronic systems intended for Aerospace and Aeronautics applications are requested to exhibit such high performances in terms of operating conditions and reliability, that the used materials must retain outstanding mechanical, thermal and electrical properties. New technological solutions must provide significant reduction of weight of parts and supports (such as electronic cases), realized with optimized shapes. A solution to such problems can be provided by exploiting the recent advances in Nanotechnology in the synthesis of the so-called nanocomposites, a class of composites where one or more separate phases have one dimension in the nanoscale (less than 100nm).

Activities: The Student will also participate to the Fourier Transform Infrared spectroscopy, and the Electron and atomic force microscopy, characterizations of the nanomaterials, e.g. graphene, nanotubes, and epoxy nanocomposites. The Student will become experienced with modelling and simulation of the CNT growth over catalyst patterned substrates and porous templates, along with the conductance properties of CNT/metal junctions, as well as in modelling CNT electron transport properties. The Student will engage in the realization and characterization of epoxy resin nanocomposites based on nanocarbon materials. and study their electrical and mechanical properties and the electromagnetic shielding they provide in the microwave frequency range.

Main references:

1. "What does see the impulse acoustic microscopy inside nanocomposites?" VM Levin, YS Petronyuk, ES Morokov, A Celzard, S Bellucci, PP Kuzhir, Physics Procedia 70 (2015) 703-706
2. "Microstructure, elastic and electromagnetic properties of epoxy-graphite composites", SS Bellucci, F Micciulla, VM Levin, Yu S Petronyuk, LA Chernozatonskii, PP Kuzhir, AG Paddubskaya, J Macutkevic, MA Pletnev, V Fierro, A Celzard, AIP Advances 5 (2015) 067137
3. "Broadband Dielectric Spectroscopy of Composites Filled With Various Carbon Materials", Stefano Bellucci, Silvia Bistarelli, Antonino Cataldo, Federico Micciulla, Ieva Kranauskaite, Jan Macutkevic, Juras Banys, Nadezhda Volynets, Alesya Paddubskaya, Dmitry Bychanok, Polina Kuzhir, Sergey Maksimenko, Vanessa Fierro, Alain Celzard, IEEE Transactions on Microwave Theory and Techniques, 63 (2015) 2024-2031
4. "Nanocomposites of epoxy resin with graphene nanoplates and exfoliated graphite: Synthesis and electrical properties", A Dabrowska, S Bellucci, A Cataldo, F Micciulla, A Huczko, physica status solidi (b) 251 (2014), 2599-2602.
5. "Heat-resistant unfired phosphate ceramics with carbon nanotubes for electromagnetic application", Artyom Plyushch, Dzmitry Bychanok, Polina Kuzhir, Sergey Maksimenko, Konstantin

Lapko, Alexey Sokol, Jan Macutkevic, Juras Banys, Federico Micciulla, Antonino Cataldo, Stefano Bellucci, physica status solidi (a) 211 (2014), 2580-2585
6. "Multi-walled carbon nanotubes/unsaturated polyester composites: Mechanical and thermal properties study", MSI Makki, MY Abdelaal, S Bellucci, M Abdel Salam, Fullerenes, Nanotubes and Carbon Nanostructures 22 (2014), 820-833

Tutor: Stefano Bellucci (bellucci@lnf.infn.it).

Activity period: June-July or September-October 2022.

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7. LNF - FRASCATI NATIONAL LABORATORY

33. NANOELECTROMAGNETICS

Title: NanoElectromagnetics (microwave/RF/photonics)

Description: We have experience in the frequency (energy)/time-domain full-wave multiphysics modeling of the combined electromagnetic-coherent transport problem in carbon-based (graphene, CNT) nano-structured materials and devices. The core concept is that while the advancement of research in this area heavily depends on the progress of manufacturing technology, still, the global modeling of multi-physics phenomena at the nanoscale is crucial to its development. Modeling, in turn, provides the appropriate basis for design. The bridge between nanosciences and the realized circuits can be achieved by using the panoply of microwave/RF engineering at our disposal. From the theoretical models and techniques, we produced efficient software for the analysis and design.
In our models, the quantum transport is described by the Schrödinger equation or its Dirac-like counterpart, for small energies. The electromagnetic field provides sources terms for the quantum transport equations that, in turn, provide charges and currents for the electromagnetic field. In the frequency-domain, a rigorous Poisson-coherent transport equation system is provided, including electrostatic sources (bias potentials). Interesting results involve new concept-devices, such as Graphene-Nano-Ribbon (GNR) nano-transistors and multipath/multilayer GNR circuits, where charges are ballistically scattered among different ports under external electrostatic control. Further examples are given by the simulation of cold-cathodes for field emission based on graphene and by the analysis of optical emission/absorption by single or few layers GNR.
Recently, we began to work on the model of the graphene/CNT-metal transition and related equivalent circuits models, ii) the inclusion of thermal effects in graphene/CNT, e.g. as deriving from ballistic path reduction due to phonon scattering and as arising at the contact between graphene and silicon dioxide.
In the time-domain, we now avail a novel Schrödinger/Dirac-based transmission line matrix (TLM) solver for the self-consistent analysis of the electromagnetic-coherent transport dynamics in realistic environments. It is highlighted that the self-generated electromagnetic field may affect the dynamics (group velocity, kinetic energy etc.) of the quantum transport. This is particularly important in the analysis of time transients and in the describing the behavior of high energy carrier bands, as well as the onset of non-linear phenomena due to impinging external electromagnetic fields. We are now capable of modelling THz carbon-based emitters/detectors, CNT-enabled traveling wave (TW-CNT) devices, and the carbon-metal transition; we are exploiting novel properties and devices based on frequency multiplication, graphene gyrotropic effects, photoconductive effects.

Activities: The Student's activity we will be focusing on:

- Multiphysics Schrödinger/Dirac-based modeling of the electromagnetic-coherent transport phenomena of the graphene/CNT devices. Microwave and Terahertz circuit characterization stemming from the above analysis in a form suitable for design.
- Models of the graphene/CNT-metal transition. Their equivalent circuits models.
- Inclusion of thermal effects in graphene/CNT (e.g. the contact between graphene and silicon dioxide). Their circuit models in system characterization.
- Characterization and validation of electromagnetic/quantum-mechanics properties of carbon nanostructures.
- Electromagnetic characterization of carbon-based foams. Shielding EM interference in chaotic environments.

Main references:

1. "Spatial dispersion effects upon local excitation of extrinsic plasmons in a graphene micro-disk" Davide Mencarelli, Stefano Bellucci, Antonello Sindona, Luca Pierantoni, Journal of Physics D: Applied Physics 48 (2015), 465104
2. "Broadband microwave attenuator based on few layer graphene flakes", Luca Pierantoni, Davide Mencarelli, Maurizio Bozzi, Riccardo Moro, Stefano Moscato, Luca Perregrini, Federico Micciulla, Antonino Cataldo, Stefano Bellucci, IEEE Transactions on Microwave Theory and Techniques, 63 (2015) 2491-2497
3. "Applications of Graphene at Microwave Frequencies", Maurizio Bozzi, Luca Pierantoni, Stefano Bellucci, Radioengineering 24 (2015) 661-669.
4. "Sharp variations in the electronic properties of graphene deposited on the h-BN layer", DG Kvashnin, S Bellucci, LA Chernozatonskii, Physical Chemistry Chemical Physics 17 (2015) 4354-4359
5. "Graphene-based electronically tuneable microstrip attenuator", L Pierantoni, D Mencarelli, M Bozzi, R Moro, S Bellucci, Nanomaterials and Nanotechnology 4 (2014), 4-18

Tutor: Stefano Bellucci (bellucci@lnf.infn.it).

Activity period: June-July or September-October 2022.

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8. LNL - LEGNARO NATIONAL LABORATORY

34. AGATA

Title: New digital electronics for the AGATA array

Description: The AGATA gamma-ray array is the state-of-the-art European gamma-ray array aiming to provide the most complete and accurate nuclear gamma-spectroscopy measurements. Its only equivalent in the world in terms of overall performances is the GRETA array in the USA. The AGATA array, currently being installed at the Legnaro National Laboratories (LNL), is covering a solid angle of 1pi, and is coupled to the large acceptance magnetic spectrometer PRISMA. The AGATA digital sampling electronics is a fundamental part of the development since the processing of the sampled signals is in the core of the position sensitivity of the instrument. At the end of 2022, the new version of the AGATA digital electronics will be installed. This implies a full characterization of the performances of the new electronics and its readout. The student will be involved in all the tests, integration and installation of the newly built electronic chain and its readout via ethernet. The new electronics channels are the key to extend the number of available channels and consequently the efficiency, sensitivity, and solid angle coverage of the array.

Activities: Hands-on digital electronics, data analysis.

Tutor: Alain Goasduff (alain.goasduff@lnl.infn.it)

Activity period: September/October 2022

Local Secretariat: Luisa Pegoraro (luisa.pegoraro@lnl.infn.it)

Other information:
LNL Summer closing period August 4 – 29
Free lunch at LNL Canteen
LNL Free Guesthouse
Agata website: https://agata.org
Local gamma group webpage: http://gamma.lnl.infn.it/

8.LNL - LEGNARO NATIONAL LABORATORY

35. LARAMED

Title: Experimental and Numerical Study of Innovative Compact Heat Sinks made by Metal Additive Manufacturing in the Turbulent Subcooled Boiling Regime

Description: The LARAMED (LAboratory of Radionuclides for MEDicine) project is devoted to R&D activities aimed at optimizing the accelerator-based production of novel radioisotopes having high potential in improving the diagnosis and treatment of cancer. One of the most critical technological challenges in increasing their yield resides in developing proper cooling systems for solid targets able to withstand the heating power generated by accelerated charged particles interaction with the bombarded material. Indeed, the LARAMED project is intended to exploit the 70 MeV high current (up to 500 μ A) proton-beam of the cyclotron of the SPES (Selective Production of Exotic Species) project present at LNL. In order to meet this requirement, cooling solutions based on optimized heat sinks in combination with the most favourable thermo -fluid dynamic parameters should be adopted. Conventional solid targets cooling systems relies on single-phase water forced convection, whereas more efficient cooling solutions, for example adopted for electronics, exploit the latent heat of vaporization of this fluid by allowing water to boil during its transit inside the heat sink channels. However, this technique is not already applied in this field due to the lack of knowledge in the design and management of this fluid regime. Thus it is of interest to correctly characterize the fluid behaviour in different thermal and hydraulic conditions to obtain the maximum advantage from this technique.

Activities: The proposed activity will include the collaboration in the experimental campaigns with the available test rig and in the related numerical simulation s for accurate benchmarking of unconventional 3D printed metal heat sink geometries. This will be carried out in both single phase and two phase flow regimes, in terms of heat transfer efficiency and pressure drop. From this point of view, the student will assist the data reduction of the acquired measurements and will learn to perform basic operations in multiphase heat transfer modelling of fluid flow with phase change . Upon acquisition of the required skills and successful completion of the assigned tasks, there will be the possibility to participate in the design of an optimized heat sink and its experimental test to validate the new manufactured geometry.

Tutors: Gabriele Sciacca (gabriele.sciacca@lnl.infn.it)
Juan Esposito (juan.esposito@lnl.infn.it).

Activity period: June-July 2022, otherwise September-October 2022

Local Secretariat: Luisa Pegoraro (luisa.pegoraro@lnl.infn.it)

Other information: The software tools Ansys, Solidworks, Matlab and Labview will be involved in the experience.
Publications and reports concerning the project:
• LARAMED: A Laboratory for Radioisotopes of Medical Interest (https://doi.org/10.3390/molecules24010020)
• Cyclotron Produced Radionuclides: Principles and Practice (https://www-pub.iaea.org/MTCD/publications/PDF/trs465_web.pdf)
LNL Summer closing period in August. Free lunch at LNL Canteen.

8. LNL - LEGNARO NATIONAL LABORATORY

36. PANDORA

Title: The PANDORA Project: reproducing a stellar environment in a Laboratory

Description: Aim of the PANDORA project is to measure the decay rate, as a function of the ionization state, for β radionuclides (like ^{176}Lu) involved in several astrophysical process and cosmology. Radioactive species will be injected in a plasma produced inside a magnetic trap (reproducing stellar-like conditions in terms of ionization stages), where they will be ionized by energetic electrons. The trap will be equipped with a complete multi-diagnostic system, able to measure not only gamma rays following the β decay, but also the plasma self-emission. In this view, a precise knowledge of the plasma density and energy distribution is mandatory. The student will learn about:

-Fundamental of plasma physics and magnetic trapping.

-The numerical approaches used to simulate and described the magnetized plasmas of the PANDORA trap.

-The techniques to inject radioactive species into the trap.

-Notions about the radioactive decay and the problems connected with the detection of gamma ray in presence of a relevant self-emitted background of radiation.

The student will also have the possibility to take part to the operations of a small-scale magnetic trap, namely an ECR ion source, used to produce ion beams to feed the accelerator complex of LNL.

Tutor: Alessio Galatà

Activity period: September-October 2022

Local Secretariat: Luisa Pegoraro (luisa.pegoraro@lnl.infn.it)

Other information:

Free lunch at LNL Canteen

LNL Free Guesthouse

8.LNL – LEGNARO NATIONAL LABORATORY

37. SiPM

Titolo: Getting used with a Silicon Photomultiplier (SiPM) to prepare the teaching material for high school student

Description of the activity:
CAEN developed a new dedicated control software for the full control of the system and the data analysis. Through a simple graphical interface, the user can manage all the parameters of both Power Supply, the Amplification Unit and the Digitizer (https://www.caen.it/products/sp5600an/). In few easy steps, the user can control the Bias and the Gain of the SiPM and also modify the thresholds and the digital outputs. In a dedicated window, the digitized signals can be monitored for real time fine tuning of the set-up. Energy Spectra, Charge vs time, Counting, Staircase plots and Time Distribution are also displayed. Data analysis is supported by advanced tools implemented in the software itself. Nevertheless, the possibility to save the data to file has been also implemented for further analysis.
The INFN LNL (https://www.lnl.infn.it) is equipped with an educational kit premium version, which let students carry out laboratory experience in many fields:

- Gamma Spectroscopy
- Beta Spectroscopy
- Cosmic rays
- Photon detection
- Study of the scintillating materials to absorber materials.

The aim of this work is firstly study and get acquainted with some of the experiments proposed by the educational kit, and afterwards write some tutorials for high school students. These tutorials will be a simplified version of the original experiences with additional material for introducing the topic and to interpreting the spectrum or data analysis. Moreover, the candidate has also to get used to the LNL radioactive sources (gamma, beta, alpha) which will irradiate with the SiPM, following the instructions present in the educational kit.

Period: 7 September - 6 November

Tutor: Carlo Roncolato

Local Secretariat: Luisa Pegoraro (luisa.pegoraro@lnl.infn.it)

Free lunch at LNL Canteen
LNL Free Guesthouse

9.LNS - SOUTH NATIONAL LABORATORY

38. KM3NET

Title: Construction of the km3net high energy neutrino telescope at 3500 m depth offshore CapoPassero

Description: High energy cosmic neutrinos were discovered in 2013 by the IceCube collaboration by means of a deep under-ice cubic kilometer telescope. This discovery opened the era of (high energy) neutrino astronomy in the very exciting and expanding field of multimessanger physics for the investigation of the violent Universe. The LNS km3net team is very active in the construction of the underwater cubic kilometer telescope for high energy neutrinos in the Mediterranean sea at 3500 depth 100 km off-shore Capo Passero. The list of activities is very large and includes construction, sea operations and installation, data taking and data analysis. The students will participate to various aspects of the projects contributing to the realization and exploitation of a gigantic, very challenging detector. km3net will be in operation for more then 10 years and it is expected to produced science at the frontier of our knowledge in synergy with photon, Gravitational Waves and cosmic ray observations.

Activities: Attività (optional)

Tutor: SAPIENZA Piera (sapienza@lns.infn.it)

Activity period: settembre-ottobre

Local Secretariat: N.Schilirò (schiliro@lns.infn.it)

Other information: web site of the laboratory www.lns.infn.it – availability of Guest House, dining room and ticket lunch.

9. LNS - SOUTH NATIONAL LABORATORY

39. DUNE

Title: Study of the performance of a Near Detector for the DUNE experiment at FNAL (USA)

Description: After the Big Bang, matter and antimatter were created equally, but now matter dominates. The study of the properties of neutrino and antineutrino oscillations to determine if charge parity (CP) symmetry is violated in the lepton sector is currently the most promising way for understanding this asymmetry. The main objective of the DUNE experiment is the measurement of the CP violation in the leptonic sector with high sensitivity (> 5 sigma). Neutrino and anti-neutrino oscillations will be measured at 1300 m from the production site in the so-called FAR detector. In order to monitor the beam and control the systematics a Near Detector (ND) close to the beam production site is necessary. Moreover the ND can exploit the unique features of (anti)neutrinos to study fundamental interactions with unprecedented precision.The LNS team is working on several topics including simulations finalized to the optimization of the ND performances. The students will have the opportunity to join the activities of the team with special focus on the development of simulations of the ND detector.

Activities: Attività (optional)

Tutor: DISTEFANO Carla (distefano_c@lns.infn.it)

Activity period: settembre-ottobre

Local Secretariat: N.Schilirò (schiliro@lns.infn.it)

Other information: web site of the laboratory www.lns.infn.it – availability of Guest House, dining room and ticket lunch.

9. LNS - SOUTH NATIONAL LABORATORY

40. FRAISE

Title: TAGGING SYSTEM LNS FRAGMENT SEPARATOR

Description: The new LNS fragment separator – FRAISE - is going to be installed. More intense radioactive beams will be available on 2023. To use these beams, we need to develop a tagging system able to event by event identify the beam in charge, mass, energy and impinging angle. This will be done using a new tagging system based on silicon carbide detectors able to sustain a yield of 10^7 particle/sec without large radiation damage. Various tests of the system must be performed to understand the its performances. Fundamental will be the synchronization between the ACQ system of the different tagging detectors that will be operated along the fragment separator and the main ACQ system of the experiment using the tagged beam.

Activities: The student will perform test with sources of the tagging system, test with random pulse generators for the synchronization of different ACQ and data analysis.

Tutor: RIZZO Francesca (rizzo@lns.infn.it),MARTORANA Nunzia Simona martorana@lns.infn.it), CARDELLA Giuseppe (Giuseppe.cardella@ct.infn.it)

Activity period: settembre-ottobre

Local Secretariat: N.Schilirò (schiliro@lns.infn.it)

Other information: web site of the laboratory www.lns.infn.it – availability of Guest House, dining room and ticket lunch.

9. LNS - SOUTH NATIONAL LABORATORY

41. CHIRONE

Title: EXPERIMENTAL ACTIVITY IN NEUTRON DETECTION SIMULATION

Description: the CHIRONE group is involved in the design and construction of the NArCoS (Neutron Array for Correlation Studies) detector array. Its prototype consists of 64 elementary cells of the plastic scintillator EJ-276G read by a SiPM, assembled in a linear cluster configuration containing four elementary cells. In the prototype 16 clusters will be assembled in a cubic geometry.
The study and construction of such proton-recoil neutron detector has been recently financed by the national PRIN2020 funding call, the name of the project being ANCHISE. The neutrons and charged particles detection at the same time is a goal that the community wants to reach in the next years, in particular with the advent of the new facility for Radioactive Ion Beams (RIBs) line FraISe, under construction at LNS.

Activities: During the stay, the student will be engaged principally in simulation activities, using the GEANT4 simulation toolkit to study the detector response with a detailed attention to the cross-talk problematic.

Tutor: RIZZO Francesca (rizzo@lns.infn.it), PAGANO Emanuele Vincenzo epagano@lns.infn.it), RUSSOTTO Paolo (russotto@lns.infn.it)

Activity period: settembre-ottobre

Local Secretariat: N.Schilirò (schiliro@lns.infn.it)

Other information: web site of the laboratory www.lns.infn.it – availability of Guest House, dining room and ticket lunch.

10. MILANO

42. LHCb

Title: Commissioning of the UT detector

Description:
The LHCb detector has undergone a major upgrade for Run3, which will start in 2022. The LHCb Milan group is deeply involved in the Upstream Tracker and it has designed and built all of the hybrid circuits that host the readout chips. Furthermore, it has been involved in the design of the cooling and other critical aspects of the detector. The detector is currently being installed underground in the experimental area. The student will be involved in the commissioning of the detector and will have the opportunity to look at the very first data collected by the tracker.

Tutor: Paolo Gandini (paolo.gandini@cern.ch), Nicola Neri (nicola.neri@cern.ch)

Activity period: September-October

Local Secretariat: Silvia Rognoni (silvia.rognoni@mi.infn.it)

Other information: Institute will be closed in August.

11. PADOVA

43. QUAX

Dark Matter Search: Axion Haloscope

Description: The QUaerere AXions (QUAX) experiment is a direct search for galactic dark matter in the form of axion or axion like particles. The detector is being built at Legnaro National Laboratories of INFN, and the collaboration includes members from the INFN sections of Padova, Salerno and Trento.
Hybrid and dielectric microwave cavities operated in multi-Tesla magnetic fields, coupled to quantum-limited receivers will allow for probing axions with (35-45) microeV mass.
Research activity is also focused on operation of a ferrimagnetic haloscope, based on the axion-electron interaction.
These experiments might in the near future help to put new insights in the understanding of our still very unknown Universe.

Activities: Mostly hardware devoted: Dilution refrigerator, microwave cavity , strong magnetic field, quantum limited microwave electronics, DAQ system

Quax webpage: https://www.pd.infn.it/eng/quax/

Tutor: Giovanni Carugno (carugno@pd.infn.it)

Activity period: June - July

Local Secretariat: salente@pd.infn.it

Possibility of cheap accommodations (hotels, b&b, guesthouses)

11. PADOVA

44. CTA

Title: Analysis of climate data obtained from a Raman LIDAR for astronomical observation with CTA

Description: The Padova group collaborates with Spanish and Slovenian colleagues on the steering of a custom-built Raman LIDAR (Light Detection and Ranging, https://ctan-lidar-pathfinder.ung.si/), and instrument used to measure the atmospheric optical depth at different heights from the ground via measuring the backscattered light from a strong pulsed laser source. The knowledge of the atmosphere opacity allows to calibrate the data from astronomical observation, specifically for the Cherenkov telescope array (https://www.cta-observatory.org/). Improvement in terms of energy resolution, bias, accuracy of the flux as well as smart scheduling are provided by the data interpretation of the Raman LIDAR.
Activities: We have collected a large sample of LIDAR data from observation at the Roque de los Muchachos Observatory (Canary Island, Spain) where the LIDAR is located and the Cherenkov Telescope Array will be installed. The candidate will analyze those data, learning the LIDAR instrument details, the LIDAR inversion algorithm, and the basic of the science with CTA, that is high energy astrophysics with gamma-rays.

Tutor: prof. Michele Doro, michele.doro@pd.infn.it

Activity period: September-October

Local Secretariat: Giuseppina Salente – email: giuseppina.salente@pd.infn.it

Other information: A reference paper**:** https://l.infn.it/j7 **.** Personal webpage: www.pd.infn.it/~mdoro

11. PADOVA

45. ICARUS - SBN

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

Activities Description

The ICARUS T600 LAr-TPC detector is presently taking data at Fermilab exposed to the Booster Neutrino Beam (BNB) and to the NUMI beam. Within the SBN program ICARUS will definitively clarify the open questions of the presently-observed neutrino anomalies hinting at the possible existence of sterile neutrinos. The T600 is taking data at shallow-depth, exposed to a large flux of cosmic rays and ~16 cosmic muons cross the detector and randomly overlap each triggered event during its 1-ms drift time window. Neutrino interactions should be disentangled from the overlapping particles and recognized among the millions of events triggered by cosmics. It is then necessary to deploy suitable automatic tools for the identification, selection and measurement of the neutrino events and for the rejection of the incoming cosmic muons.

The student will be involved in the analysis of the neutrino events collected. The student will first of all contribute to the validation and improvement of the event reconstruction tools and on the development of the selection tools to automatically recognize the neutrino interactions. The goal of the activities is to obtain a first evaluation of the event reconstruction efficiency for the neutrino interactions and for the cosmic rays. The activity offers also to the student the unique opportunity to participate to a modern large-scale neutrino experiment and to gain a significant experimental experience.

Recommended Period: ***Settembre/Ottobre 2022***
Local Secretariat: Giuseppina Salente
Tutor: Christian Farnese

11. PADOVA

46. GAMMA - RIKEN

Title: Exclusive cross section measurement of 52Fe excited states populated via knockout reactions.

Description: Knockout reactions measure the probability of nucleon removal from the projectile after interacting with the target, by the observation of the surviving nucleus. These reactions are studied between 100 – 200 MeV/A, where interaction with the target can be taken to be extremely peripheral so that the it will involve the tail of the projectile wave function and the target nucleus. Knockout reactions have well-defined two-body initial and final states, and the probability for this process depends strongly on structural overlap contributions. The transferred nucleon is represented as being in a single particle orbital before and after the transfer, or at least in a state that can be represented as a linear combination of such wave functions. Different contributions from different orbitals to the transfer process are taken into account by spectroscopic factors. Exclusive cross sections represent the probability to populate a particular excited state in the projectile after the nucleon removal. Thus they are directly related to the spectroscopic factors and they represent a powerful tool to investigate the nuclear structure.

The student will have the possibility to measure exclusive cross sections for the excited states populated in 52Fe via knockout reactions at the RIKEN-Nishina Center for Nuclear Study (Japan).

Recommended period: June-July / Septermber-October 2022

Tutor: Sara Pigliapoco (sara.pigliapoco@pd.infn.it)
Francesco Recchia (francesco.recchia@pd.infn.it)

Local Secretariat: segr_gr3@pd.infn.it

Marina Andreazzo
Telefono: 049.967.7257
Ufficio: 366 (III piano)
E-mail: marina.andreazzo@pd.infn.it

11. PADOVA

47. LHCb2

Title: Efficient *b*- and *c*-jet identification at the LHCb experiment using quantum machine learning

Description: The LHCb experiment at CERN has already demonstrated its capability of performing measurements with *b*- and *c*-jets. With the upgraded detector LHCb will have the possibility to collect a huge sample of jets that, for example, could be used to search for the rare Higgs decay into two charm quark jets.
In order to efficiently select *b*- and *c*-jets at trigger level, rejecting most of the background, it is necessary to use a reliable and fast identification algorithm.
ATensor Network trained with quantum-based techniques is one of the best and most innovative options on the market for such purpose. These kind of algorithms are in fact designed to run on real quantum computers, like those available in the IBM quantum experience framework.
The proposed project sees a student involved in the understanding of jet properties. Thereafter he/she will be involved in the application of aTensor Network to collider data. He/she will study the performance of the classifier, comparing them with the performance of other machine learning methods, like Deep Neural Networks.

The project is structured in different phases in which the student will:

- learn the concept of *b*- and *c*-jet objects and how they are identified;
- learn the concept of classical machine learning with Deep Neural Networks and of quantum machine learning with Tensor Networks;
- apply the Quantum Tensor Network and Deep Neural Network to collider data and measure the efficiency and mis-identification rate;
- compare the inference time of the different methods.

The student will have the possibility to work with a physicist expert on jet reconstruction and with a computing scientist.

Activity period: June-July or September-October 2022
Tutors: Lorenzo Sestini (lorenzo.sestini@pd.infn.it), Donatella Lucchesi (donatella.lucchesi@pd.infn.it)
Local Secretariat: Cristina Miletti - segreteria-gruppo1@pd.infn.it

11. PADOVA

48. LHCb1

Title: Test of Lepton Flavour Universality with LHCb exploiting multivariate techniques

Description: In the Standard Model (SM), the couplings of the gauge bosons to the leptons are independent of the lepton flavour. As a consequence the semi-leptonic branching fractions differing only by the flavour of the final state leptons can differ only by phase space and helicity-suppressed contributions (the Lepton Flavour Universality or LFU). The LFU appears in the SM by construction and therefore any violation of it would be a clear sign of physics beyond the SM. Hints of non universality have already been observed in Electroweak Penguin processes and in the semi-tauonic B meson decays by the BaBar, BELLE and LHCb experiments making this subject a very interesting research topic.

Activities: The candidate will participate to the study of LFU with the LHCb detector through the study of b-Baryon decays. LHCb is in fact the only experiment that has the capability to study in detail these types of semileptonic decays and therefore to check the universality in the baryonic sector.
The candidate will study in particular Λ_b semi-tauonic decays proceeding involving baryons aiming at the the measurement of the ratio $R_{\Lambda_c^*} = \mathcal{B}(\Lambda_b^0 \to \Lambda_c^{*+}\tau^-\bar{\nu}_\tau)/\mathcal{B}(\Lambda_b^0 \to \Lambda_c^{*+}\mu^-\bar{\nu}_\mu)$, where $\Lambda_c^{*+} = \Lambda_c^+(2595, 2625)$.
In the first part of the project the student will be involved in the study of the separation between signal and background for run2 data by means of multivariate classification algorithms exploring also the performance deep neural network classifiers. In the second part of the project, the student will refine a multidimensional fit algorithm to extract the semi-tauonic signal yield and perform simulated pseudo-experiment to determine the sensitivity of the signal extraction method.

Tutors Simi Gabriele (gabriele.simi@pd.infn.it)

Activity Period: June-July, September-October 2022

Local secretariat: Local Secretariat: segreteria-gruppo1@pd.infn.it

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Cristina Miletti
Telefono: 049.967.7080
Ufficio: 133 (I piano)
Mail: miletti@pd.infn.it

Other information: `https://web.infn.it/LHCb_padova/index.php/en/`

12. PAVIA

49. RF_FCC and HiDRa

Title: Dual Readout Calorimeter R&D for FCC

Description: Qualified students will participate in the development of a full scale prototype based on the Dual-Readout technique, which is one of the most promising calorimetric approach for high-resolution detector. The technique has been developed since about 15 years, and it is now consolidated. On the other hand, studies for feasibility application for a real experiments are now ongoing.
The prototype under development is meant to experimentally asses the hadronic performance of this type of calorimeter, allowing to provide clear indication on the construction technique toward a technical design report for Future Experiment. Moreover, the high-granularity readout based on silicon photomultipliers will make it possible to test and validate at an unprecedented level the Monte Carlo models of calorimeter shower developments.

Activities: The student will be involved in different aspects of the research program.

- Construction and quality control of the prototypes
- Development of both hardware and software tools
- Simulation of the prototype and data analysis: comparison of Monte Carlo predictions with data
- Data analysis of test beam data

Tutor:

- Roberto Ferrari – roberto.ferrari@pv.infn.it
- Gabriella Gaudio - gabriella.gaudio@pv.infn.it

Activity period: June 6th -July 29th or September 5th – October 28th

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

Other information:

- Institute will be closed for part of August
- Pavia offers a number of hosting opportunities in the University colleges
- https://fisica.dip.unipv.it/en/research/research-teams-and-topics/experimental-nuclear-and-subnuclear-physics/rdfcc

13.PISA

50. SWEATERS

Title: Characterization measurements of a gas detector based on bulk-MicroMegas technology for low energy ionizing particles of SWEATERS Project

Description: In the last years Micro-Megas gas detectors have been widely used as tracks reconstruction instrument of ionizing particles, operating at standard temperature and pressure (STP), in high energy physics experiments on the modern colliders.
At the INFN Pisa Laboratory an experimental group involved in the gas detectors research activity, is developing a gas chamber detector, based on the bulk-MacroMegas (MM) technology, to be filled and operated with different gas mixtures at low pressure down to 50 mbar.
Thanks to the encouraging results obtained so far, the working group is conceiving a gas detector with the possibility to reconstruct the incident ionizing particle in 3D, and with a good energy track resolution in the range 1-100 keV. These features will be very innovative for future applications of MM detectors in the Dark Matter (DM) search and Space Weather monitoring.
The proposed task of this stage period, deals with a typical laboratory activity to be carried on with the goal performing a characterization measurement campaign on a (10 x 10) cm2 Micro-Megas chamber prototype of the SWEATERS Project.

Time Period: September-October 2022

Location: INFN Virgo Pisa Laboratory, Largo B. Pontecorvo, 3 – Building C (Pisa downtown)

Tutor: F. Pilo – INFN Pisa; e-mail: Federico.pilo@pi.infn.it
F. Frasconi – INFN Pisa; e-mail: franco.frasconi@pi.infn.it

Other Information: INFN Laboratory will be closed in the time period: August 6 – August 28, 2022 included. Due to the pandemic emergency, students are asked to be fully vaccinated to have access to the university and INFN building.

Local Secretariat: Dr. Giacomo Bett Ph.: +39.050.2214 270 e-mail:
giacomo.betti@pi.infn.it

13. PISA

51. VIRGO - ET

Title: Laboratory measurements campaign by using high precision and low noise sensors for future Gravitational Waves detectors

Description: The INFN Pisa Group, deeply involved in the construction and continuous operation of the Advanced VIRGO interferometer for Gravitational Waves direct observation on Earth, is starting a detailed Research and Development (R&D) program to prepare the new anti-seismic suspension for the optical components of the 3rd generation detectors.
To this purpose a detailed comparison of micro-seismic motion measurements carried out with different available sensors, represent a key point for the future developments of high precision and low noise device. The final goal is the development of a new sensor to be integrated within a future suspension system for seismic noise suppression at the level of the optical components. Starting from the characterization measurements for each sensor, the possibility to integrate different components in a single multi-sensors device will be evaluated.
This task is considered very challenging for many aspects: the required sensitivity, the material selection for its construction, the presence of a low noise and high sensitivity front-end electronics on board with the possibility to be included in the feedback control strategy of an inertial platform with six degrees of freedom.

Time Period: September-October 2022

Location: INFN Virgo Pisa Laboratory, Largo B. Pontecorvo, 3 – Building C (Pisa downtown)

Tutor: F. Frasconi – INFN Pisa; e-mail: franco.frasconi@pi.infn.it

Other Information: INFN Laboratory will be closed in the time period: August 6 – August 28, 2022 included. Due to the pandemic emergency, students are asked to be fully vaccinated to have access to the university and INFN building.

Local Secretariat: Dr. Giacomo Bett Ph.: +39.050.2214 270 e-mail: giacomo.betti@pi.infn.it

SEDE: 14. Sezione di Roma

Project 52. ANDROMeDa

Title: ANDROMeDa

Description: The ANDROMeDa (Aligned Nanotube Detector for Research On MeV Darkmatter) project aims to develop the Dark-PMT, a novel dark matter detector based on vertically-aligned carbon nanotubes. You will be directly participating to the design, construction and operation of a Dark-PMT prototype.

Tutor: Francesco Pandolfi (fracesco.pandolfi@roma1.infn.it) or Gianluca Cavoto (gianluca.cavoto@roma1.infn.it).

Activity period: June-July or September-October.

Local Secretariat: Mauro Mancini (mauro.mancini@roma1.infn.it) Tel. ++39 0649914318

Other information:

15. ROMA2

53. FastCaloGAN

Title: FastCaloGAN, a fast calorimeter simulation tool for ATLAS

Description: The student will work on the optimisation of the training of the GANs that will be deployed in the new version of AtlFast3 that will be used by the ATLAS collaboration during Run3.

Activities: Train of GANs in Klong, (anti-)protons and (anti-)neutrons.
Deployment of FastCaloGAN in a docker container
Deployment on sites different from CERN
Implementation of new models

Tutor: Michele Faucci Giannelli

Activity period: June-July or September-October

Local Secretariat: Referente segreteria locale,
Carla Felici carla.felici@roma2.infn.it
Maria Mazzei maria.mazzei@roma2.infn.it

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

16. TORINO

54. LUNA

Title: Characterization of an array of HPGe and scintillator detectors for low energy nuclear astrophysics 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), whose mission is to study charged-particle-induced nuclear reactions of astrophysical interest. The proposed activity focuses on the development of an array of HPGe detectors 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 and of low-mass stars in close binary systems, whose understanding is of paramount importance for the comprehension of supernova outcomes. The $^{12}C+^{12}C$ fusion in stars proceeds primarily through the $^{12}C(^{12}C,\alpha)^{20}Ne$ and the $^{12}C(^{12}C,p)^{23}Na$ reactions. The cross sections of these processes are extremely low, in the sub-femto-barn range. Successful modelling of supernovae requires the cross sections to be known down to around 1.5 MeV. Due to the extremely small cross sections, direct experiments are challenging already at energies above 2.2 MeV. Measurements may be done detecting the γ rays generated by the decay of the ^{23}Na and ^{20}Ne excited states. Thanks to 1400 meters of rock overlying the experimental halls, LNGS is the ideal location to perform a γ-ray detection experiment. The idea is to combine the high resolution of HPGe detectors with the high efficiency of scintillator detectors. The candidate will work to find the best design and configuration of the crystals to maximize the gamma detection efficiency and the background reduction exploiting anti-coincidence techniques. The work will be done at INFN Torino with several visits to LNGS.

Tutor: Francesca Cavanna (francesca.cavanna@to.infn.it)

Activity period: June – July or September – October 2022

Local Secretariat: Valentina Lissia, valentina.lissia@to.infn.it

Other information: https://luna.lngs.infn.it/

17.TRIESTE

55. ITS3

Title: 65 nm CMOS test structures characterization

Description:
A quasi-massless, truly cylindrical silicon detector based on Monolithic Active Pixel Sensors (MAPS) technology is being currently developed. Such a detector, named ITS3, will upgrade the Inner Tracking System for the ALICE detector at LHC in 2026 and will be adapted to the geometry of Electron Ion Collider experiment to serve as vertexing detector. Institutes from ALICE ITS3 and from EIC are working together towards this common solution. To achieve the target performance, the design of a new large-area (30 cm x 10 cm), extremely reduced thickness (20-30 microns) monolithic pixel sensor based on 65 nm CMOS process, is now ongoing, with the goal of building a series of curved silicon layers without additional infrastructures.
In Trieste, the ITS3 R&D for 2022 will focus on the characterization in laboratory of 65 nm CMOS process test structures featuring different architectures, structure geometries, CMOS processes, silicon characteristics, and will extend to sensors in curved geometry, in preparation for the test of the future large-area prototypes. These activities started at the beginning of 2022 and will continue through the rest of the year. The student will participate in the tests, contribute to the development of test procedures and software, gain experience in the interpretation of the results and learn how the sensor design affects the sensor performance. The work will train the student to conduct independent tests of the CMOS sensors.

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

Activity period:
Preferably June-July 2022.
September-October 2022 can also be considered.

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/