

BARI

ALICE

Title: Study of open beauty production in Pb-Pb collisions in the ALICE experiment using semi-inclusive decays.

Description: The ALICE experiment at the LHC is dedicated to the study of heavy ion collisions to characterize the properties of strongly interacting matter at very high temperature and low baryo-chemical potential. Heavy quarks are an important probe for the properties of this state of matter, since they are produced via hard partonic collisions at a very early stage and thus experience the complete evolution of the system. The production of open beauty hadrons is expected to be very sensitive to the density of the medium created in heavy-ion collisions due to the energy loss experienced by the parent parton (a beauty quark), which hadronizes into the beauty hadron. Their production can be studied in ALICE, e.g., by using semi-inclusive decays like $B \rightarrow J/\psi + X$ or $B \rightarrow D^0 + X$. The student will contribute to analyse the data collected by the ALICE experiment by applying the fitting procedure to extract the fraction of non-prompt J/ψ (coming from the decay of beauty hadrons) or non-prompt D^0 mesons (also coming from the decay of beauty hadrons). From these fractions, by knowing the inclusive production of J/ψ (or D^0 meson) already measured by ALICE, it would be possible to determine the production of beauty hadrons.

Tutor: Prof. Giuseppe Eugenio Bruno

Recommended period: June - July

Other information: Institute will be closed 05/08 – 16/08

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

BARI

CMS 1

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 to the necessity to both handle and visualize easily huge amount 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 core 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. 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)

Recommended period: June-July (highly preferred) or September-October

Other information: Institute will be closed 05/08 – 16/08

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

BARI

CMS 2

Title: Search for dark matter through a “mono-Higgs” signature with four leptons in the final state, with the CMS experiment at the LHC.

Description: Within the framework of the searches of the dark matter with the CMS experiment, this project focuses on the one expecting a Higgs boson produced in association with a dark matter pair, the so called “monoHiggs” signature, with four leptons in the final state, coming from the Higgs boson decay. This signature will be studied in the context of “Higgs Portal” theoretical models and other simplified approaches. The analysis would involve the optimization of reconstruction of leptons and missing energy and the estimate of the background from data. We expect to investigate the use of multi-variate analysis techniques to improve the signal to background rejection. Studies about the observables as expected by the Monte Carlo simulation with 2016 and 2017 data are foreseen. A statistical interpretation of the results in the context of a Higgs portal model would be the final goal of the analysis. An extension of the studies in the context of the CMS upgrade is also expected.

Tutors: Nicola De Filippis (Nicola.Defilippis@ba.infn.it)

Recommended period: June-July or September-October

Other information: Institute will be closed 05/08 – 16/08

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

BARI

CMS 3

Title: Study of triple Higgs coupling through the double Higgs production with the CMS Run 2 data at 13 TeV and with future colliders at 100 TeV.

Description: The project will focus on the study of the performance on the measurement of the triple Higgs coupling at the LHC at center of mass energy of 13 and at a future collider at 100 TeV; the production of a Higgs pair and the decay in two $b\bar{b}$ ZZ will be studied; the subsequent decay of the ZZ pair in four leptons final state will be the main focus. Signal and background events will be simulated, if not existing, and reconstructed with the CMS software for the upgrade and with a fast simulation tool in case of the future collider at 100 TeV. The student is expected to study the performance of the b-tagging and of the leptons reconstruction/identification, also by profiting from the usage of multivariate analysis techniques. The goal of the project is to get an estimate of the rate of di-higgs expected with this topology, an upper limit on the value of the triple Higgs coupling and an estimate of the uncertainty on the measurement on the coupling with a future allied at 100 TeV.

Tutors: Nicola De Filippis (Nicola.Defilippis@ba.infn.it)

Recommended period: June-July or September-October

Other information: Institute will be closed 05/08 – 16/08

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

BARI

CMS 4

Title: Measurement of the cross section for the production of the Higgs boson via a vector boson fusion in the channel $H \rightarrow ZZ \rightarrow 4l$ with the CMS experiment at the LHC.

Description The project will focus on the study of the vector boson production of the Higgs boson when this decays through the $H \rightarrow ZZ \rightarrow 4l$, by using the full Run 2 statistics of data collected by CMS in 2016-2018. The analysis would involve the optimization of reconstruction of leptons and jets and the estimate of the background from data. We expect to use of machine learning techniques to improve the signal to background rejection. Studies about the observables as expected by the Monte Carlo simulation are foreseen. We would expect to quote the significance of the discovery of the Higgs with the vector boson fusion production mode in the $H \rightarrow ZZ \rightarrow 4l$; a full statistical analysis will be implemented also including the effect of systematics uncertainties.

Tutors: Nicola De Filippis (Nicola.Defilippis@ba.infn.it)

Recommended period: June-July or September-October

Other information: Institute will be closed 05/08 – 16/08

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

BOLOGNA

ATLAS 1

Title: ITk module testing

Description: In 2025 the ATLAS experiment will complete one of its most ambitious upgrade plans: the replacement of the whole Inner Detector (ID) tracker with ITk a silicon-based tracker with unprecedented performance, complexity, geometrical coverage and radiation hardness.

Bologna ITk group is involved in quality certification and quality assessment (QA/QC) of the silicon modules composed by the silicon sensor and the front end read out chip.

The activity will focus on the setup of the system for module QA/QC in the newly built clean room and performing the various tests: including optical inspections, electrical characterization and functional tests both at room and at low temperature (down to -40 °C).

Besides taking part to the tests performed in the lab, according to her/his interests, the student will also contribute to one or more of these activities: setup of cooling system, setup of DCS system (system that controls low and high voltage, operating temperature and humidity etc.), interlocks, data acquisition of the modules.

Tutor:

Alberto Cervelli (alberto.cervelli@bo.infn.it)

Carla Sbarra (carla.sbarra@bo.infn.it)

Recommended period: June-July, September-October (tolerance of ~ 1 week can be accorded)

Other information:

Vacation period of the Bologna INFN division: August 1-25, 2019

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

Local Secretariat:

Ms. Elena Amadei (elena.amadei@bo.infn.it)

Ms. Barbara Simoni (barbara.simoni@bo.infn.it)

BOLOGNA

ATLAS 2

Title: New physic searches in ATLAS

Description: The search for physics Beyond Standard Model (BSM) is a major part of the ATLAS physics program. Many different BSM models allow for final states with one or more leptons with reduced Standard Model background. Among those models, our group focuses its research in SUSY and Exotics searches.

New physics events are searched in several processes. SUSY and exotic searches share similar strategies and analysis frameworks. The proposed activity will cover search for SUSY production of particles decaying WW bosons and neutralinos while for exotics we will focus on leptoquarks, doubly charged Higgs bosons ($H^{\pm\pm}$) production or charged leptons predicted, for example, by mechanisms like Type-III SeeSaw.

The perspective student, according to his/her own inclinations, will be able to contribute to either or both the analysis focusing on sensitivity studies, background estimation, and signal optimizations.

Tutor:

Alberto Cervelli (alberto.cervelli@bo.infn.it)

Antonio Sidoti (antonio.sidoti@bo.infn.it)

Recommended period: June-July, September-October (tolerance of ~ 1 week can be accorded)

Other information:

Vacation period of the Bologna INFN division: August 1-25, 2019

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

Local Secretariat:

Ms. Elena Amadei (elena.amadei@bo.infn.it)

Ms. Barbara Simoni (barbara.simoni@bo.infn.it)

BOLOGNA

XENON

Title: Study of the neutron background in the XENONnT dark matter experiment

Description: The XENON project, hosted in the INFN Gran Sasso National Laboratory, is dedicated to the direct search of dark matter particles. It consists of a double-phase time projection chamber using ultra-pure liquid Xenon. The latest version of the detector, XENON1T, with an active target mass of 2 t, is the largest TPC ever built and operated for dark matter search. Thanks to a careful selection of construction materials, a dedicated distillation of the xenon target, and an active muon veto system, the background level in the inner 1t fiducial region is about 2×10^{-4} dru, the lowest ever achieved in a direct dark matter experiment. The results of the 1 tonne*year XENON1T science run allowed to obtain a limit of $4.1 \times 10^{-47} \text{ cm}^2$ for a 35 GeV WIMP mass, which is the lowest cross section ever probed to date.

To further increase the sensitivity, its future upgrade, XENONnT, is already under construction at LNGS, with an active mass of 6 t.

One of the most relevant backgrounds in the XENONnT phase will come from radiogenic neutrons scattering elastically off Xe nuclei, mimicking the same signature of WIMPs.

The student will be involved in the characterization of the PMTs used in the new dedicated XENONnT neutron veto system, to tag neutrons and reduce the related background.

Tutor: Marco Selvi (selvi@bo.infn.it)

Recommended period: June-July

Other information:

Vacation period of the Bologna INFN division: August 1-25, 2019

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

Local Secretariat:

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Ms. Barbara Simoni (barbara.simoni@bo.infn.it)

CAGLIARI

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 collision 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 bottomonium, charmonium and open charm in the PbPb and pPb samples collected in 2015, 2016 and 2018, with particular attention to the D0, J/psi and Upsilon mesons. In these samples, the candidate will extract the signal yields corrected for the efficiencies she/he measured in the dedicated Monte Carlo samples. The ratio of the states can be measured, which gives crucial indications on the formation of Quark Gluon Plasma.

References:

- * S.Chen et al. [LHCb collaboration], Study of Upsilon production in pPb collisions at $\sqrt{s} = 8.16$ TeV, LHCb-PAPER-2018-035.
- * A.Bursche et al. [LHCb collaboration], Study of coherent J/psi production in PbPb collisions at $\sqrt{s} = 5$ TeV with the LHCb experiment, LHCb-CONF-2018-003.
- * Y.Zhang et al. [LHCb collaboration], Study of cold nuclear matter effects using prompt D0 meson production in pPb collisions at LHCb LHCb-CONF-2016-003.
- * J.Blouw et al., Proposal for LHCb Participation to the Heavy Ion Runs, LHCb-INT-2015-019 (only visible to LHCb collaborators).

Tutor: Giulia Manca (Giulia.Manca@cern.ch)

Recommended period: June 1st - August 4th or September 5th - October 31st

Administration and Logistic:

[Maria Grazia Dessi](#) (Administration Office)

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Scientific coordinator:

Giulia Manca (Giulia.Manca@cern.ch)

Local web page:

<http://www.ca.infn.it/DOE/doe.html>

CAGLIARI

DarkSide

Title: Dark Matter searches with the DarkSide experiment

Description: DarkSide-50 is a two-phase time projection chamber (TPC) filled by 50 kg of liquid argon (LAr) and installed at Laboratori Nazionali del Gran Sasso. It has released recently three major results in the search for dark matter scattering on nuclei (and electrons) in the high mass range [1] and in the low-mass range [2] ([3]) obtaining in the last case the world leading limit on the WIMP-nucleon (WIMP-electron [3]) cross section versus the WIMP mass parameter space. While DarkSide-50 will continue to take data, research and development to build and operate a series of larger DarkSide LAr TPCs for WIMP detection is also being carried out. The intent is to progress to multi-ton detectors with the highest sensitivity for high and low-mass WIMP detection. Indeed, DarkSide-20k [4], a LAr TPC capable of collecting an exposure of 100 tonne year, has been proposed by the DarkSide Collaboration. This detector is expected to operate in a so-called background free regime, so that a positive claim can be made with as few events as possible. This means that for the nominal exposure the number of instrumental background interactions will be kept to less than 0.1 events, apart from background events induced by Coherent Elastic neutrino-Nucleus Scattering (CENNS). The candidate will be involved in the analysis of DarkSide-50 data and/or in simulation studies for the sensitivity of the future DarkSide-20k detector.

References:

- [1] P. Agnes et al. (DarkSide Collaboration), Phys. Rev. Lett. 121 (2018) no.8, 081307.
- [2] P. Agnes et al. (DarkSide Collaboration) Phys. Rev. D 98 (2018), 102006.
- [3] P. Agnes et al. (DarkSide Collaboration) Phys. Rev. Lett. 121 (2018) no.11, 111303.
- [4] P. Agnes et al. (DarkSide Collaboration) Eur. Phys. J. Plus 133 (2018) 131.

Tutor: Dr. Matteo Cadeddu (matteo.cadeddu@ca.infn.it)

Recommended Period: September 5th - October 31st

Administration and Logistic:

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<http://www.ca.infn.it/DOE/doe.html>

CATANIA

JUNO

Title: Study of neutrino oscillations and mass hierarchy with the JUNO experiment: exploring silicon photo-multipliers as optimal choice for the detection of scintillation light from inverse beta-decays

Description: Understanding neutrino oscillations and mass hierarchy is one of the most challenging problems in particle and nuclear physics. Some experiments are carried out with antineutrinos produced by nuclear reactors. Fission products inside the reactor core undergo beta-decay processes, producing electron antineutrinos, detected via the so-called inverse beta-decay process (IBD) occurring inside liquid scintillator materials. The thus-generated positrons annihilate with electrons in the scintillator, producing prompt gamma rays, while the generated neutrons are thermalized and captured either by a proton or by a heavier nucleus specifically added to the scintillator material, thus generating a secondary cascade of gammas.

The detection of both prompt and delayed gammas allows the identification of the incident antineutrino and the measurement of its kinetic energy. The reconstruction of this kinetic energy with high precision is key to improving our understanding of neutrino oscillations.

In this area of interest, the JUNO (Jiangmen Underground Neutrino Observatory) (see <http://juno.ihep.cas.cn>) is a multipurpose neutrino experiment designed to determine neutrino mass hierarchy and precisely measure oscillation parameters by detecting reactor neutrinos from the Yangjiang and Taishan Nuclear Power Plants, observe supernova neutrinos, study the atmospheric, solar neutrinos and geoneutrinos, and perform exotic searches, with a 20-thousand-ton liquid scintillator detector of unprecedented 3% energy resolution (at 1 MeV) at 700-meter deep underground.

For this purpose, the present project aims at exploring the improvement attainable in antineutrino energy measurements by using silicon photo-multipliers (SiPM) rather than conventional photo-multiplier tubes (PMT) to read-out light produced by the liquid scintillator as a consequence of the above-mentioned gamma signals, both prompt and delayed.

Activity: In the present project, the student joining the Catania JUNO group will experience research participating and working on an R&D program consisting of:

- a) studying the performances of different SiPM tiles available in the market by using high resolution lasers with variable wavelength and emission frequencies;
- b) studying the effect of decreasing temperatures on the performances of SiPM (decreasing dark current) as well as on the optical properties of the liquid scintillator material to be read-out by the optical sensors;
- c) exploring solutions, by means of computer simulations and laboratory tests, to thermally isolate the SiPM from the liquid scintillator if low temperature effects, certainly beneficial to SiPM operation, may induce a degradation of the liquid scintillator performances;
- d) design (not construction) of a testing prototype solution to be explored as a proof of principle.

Recommend period: September-October 2019

Tutor: Prof. Rossella Caruso (rossella.caruso@ct.infn.it)

Local Secretariat: Anna Linda Magri (annalinda.magri@ct.infn.it)

CATANIA

AUGER (Study of Ultra High Energy Cosmic Rays at the Pierre Auger Observatory)

Title: Test and validation of the HV power supplies for AugerPrime, upgrade of the Pierre Auger Observatory

Description: The Pierre Auger Observatory (<http://www.auger.org>), in the Pampa Amarilla near Malargue (Argentina), is an international scientific experiment with the objective of studying the highest energy cosmic rays (10¹⁷eV-10²¹eV). The origin and accelerating process of these particles is still unknown. Their rate is extremely low. One expects approximately one cosmic ray arriving on an area of one km² per century. In order to collect a significant statistics, the Pierre Auger Observatory covers an area of 3000 km². The cosmic rays properties are measured by two independent detector systems. The Surface Detector is a giant array of 1600 water Cherenkov tanks, placed over the area with 1.5 km spacing. The Fluorescence Detector is a telescope system which reconstructs the cosmic ray shower from the fluorescence light emitted by the atmospheric nitrogen excited by the particles of the shower. Surface arrays measure the lateral distribution of particles in air showers when they strike the ground. Fluorescence detectors view the longitudinal development of showers as they move downward through the atmosphere. These two complementary techniques form a uniquely powerful instrument to study the nature of extreme energy cosmic rays. The Observatory is expected to measure the arrival direction, the energy and mass composition of primary cosmic rays collecting about 5000 events per year above 10¹⁹ eV.

At the present the Pierre Auger Observatory has produced results on:

- the energy spectrum of the primary cosmic rays which clearly shows a suppression of the flux for energy larger than 5x10¹⁹ eV;
- an indication of the extragalactic sources of the very energetic cosmic rays;
- indication of the mass composition of the UHECRs;
- limits on photons and neutrinos.

The Collaboration has proposed an upgrade (**AugerPrime**) of the Pierre Auger Observatory to increment its sensitivity to the mass of the primary.

Activity: A new single channel HV power supply (A7501PB) was developed by the CAEN factory in a cooperative effort with INFN-Section of Torino to supply the new photomultipliers used for AugerPrime. This unit was designed to work in the challenging environmental conditions and high thermal excursions of the Argentinian Pampa offering high reliability, low consumption and very low ripple. A proper test system and the procedure were developed to check and validate the HV boxes by the Auger Torino group. For the production phase, two of these facilities are currently operative in Italy: one in Torino and another identical one in Catania.

The student joining the Catania Auger group will experience research working on a small project, having the opportunity to deal with different aspects connected with these measurements, e.g.:

- test of the HV boxes (batches of 100-200 units): test of linearity and stability at room temperature plus test of thermal stress with controlled temperature cycles inside a climatic chamber;
- data analysis and validation of HV boxes before their installation in the field;
- data storage and database usage.

Recommend period: June-July or September-October 2019

Tutor: Prof. Rossella Caruso (rossella.caruso@ct.infn.it)

Local Secretariat: Anna Linda Magrì (annalinda.magri@ct.infn.it)

CATANIA

JLAB12-BDX

Title: Light Dark Matter search in a Beam Dump eXperiment (BDX) at Jefferson Lab

Description: BDX is an experiment proposed to run at Jefferson Lab (Virginia, USA), ideally suited to potentially discover light Dark Matter particles which feel a new interaction carried out by a hypothetical new U(1) gauge boson, the so-called Dark- or Heavy-photon.

The Collaboration counts more than 100 researchers, many of them from Italian and U.S.A. Labs and Universities.

The experiment has been recently approved with the maximum scientific rate by the JLAB PAC46 and a preliminary proof-of-principle run is foreseen this year.

The Catania research group is actively involved in the management and preparation of the experiment. The student joining the Catania group will have the opportunity to experience a research activity on different aspects of the project, such as Data Analysis, Simulations and software development (C++).

Recommend period: September-October 2019

Tutor:

Mariangela Bondi (mariangela.bondi@ct.infn.it) Marzio De Napoli (marzio.denapoli@ct.infn.it)

Local Secretariat: Anna Linda Magri (annalinda.magri@ct.infn.it)

Other info: Closure period August

FERRARA

LHCb

Title: The Ring Imaging Cherenkov (RICH) detector upgrade project of the LHCb experiment: R&D activities and characterization of photo-detectors and electronics, including radiation hardness tests.

Description: LHCb is one of the main experiments collecting data at the Large Hadron Collider accelerator at CERN. Its primary goal is to study with high accuracy b and c quark decays to improve the knowledge of the Standard Model or to reveal the contributions of New Physics to the decay processes. One of the main features of the LHCb experiment is the capability to identify the particles produced in the final state. Several detectors are dedicated to this purpose. In particular the separation between pions, kaons and protons is provided by two Cherenkov imaging detectors (RICH-1 and RICH-2). The identification of muon particles is performed using a dedicated detector. LHCb will be upgraded in many of its sub-detectors after the Long Shutdown 2 (2019-2020): to cope with the luminosity increase the read-out electronics will be upgraded to 40 MHz and the detector geometry will be modified to reduce the occupancy. This will allow the data rate to be increased substantially. The HPD photon detectors and readout electronics will be replaced by new photo-detectors with external new 40 MHz readout electronics. The Ferrara University and INFN group is involved in both the RICH and Muon detectors.

Activities: The student, joining the Ferrara group in Summer 2019, will have the opportunity to participate to the different R&D activities: - test and characterization of novel photo-detectors - test and characterization of CMOS front-end electronics, eventually including radiation hardness tests at European facilities - detector simulations.

Tutor: Massimiliano Fiorini (fiorini@fe.infn.it)

Recommended period: June-July or July-August

Other information: cheap accommodation available in town or in the University guest house.

Local Secretariat:

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Local web page:

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FRASCATI NATIONAL LABORATORY

SIDDHARTA-2

Title: Kaonic atoms measurements by the SIDDHARTA-2 experiment on DAFNE accelerator: strangeness in neutron stars.

Description of the activity: 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 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 will be installed on DAFNE, an electron-positron collider delivering kaons, starting with Spring 2019; a very exciting period will then follow! 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).

The student will be involved in all the exciting phases of the experiment, from the installation on the DAFNE collider, one of the very few working colliders in the world, to tests of the detector systems and data acquisition. He/she will be also introduced to data analyses and advanced Monte Carlo simulations.

Period: September-October 2019

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

Other Information:

- Accommodation: students may be accommodated in the LNF guesthouse, free of charge.
- LNF Summer closing period: 5-16 August 2019

Local Exchange Program Contacts:

Catalina Curceanu (coordinator) catalina.curceanu@lnf.infn.it

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FRASCATI NATIONAL LABORATORY

CYGNO

Title: Advanced detectors for directional Dark Matter search

Description of the activity: At the National Laboratory of Frascati is under design the CYGNO project. CYGNO is a new proposal supported by INFN, the Italian National Institute for Nuclear Physics, within CYGNO's proto-collaboration (CYGNUS-TPC) that aims to realize a distributed observatory in underground laboratories for directional Dark Matter (DM) search and the identification of the coherent neutrino scattering (CNS) from the Sun. CYGNO is one of the first prototypes in the road map to 100-1000 m³ of CYGNUS and will be located at the National Laboratory of Gran Sasso (LNGS), in Italy, aiming to make significant advances in the technology of single phase gas-only time projection chambers (TPC) for the application to the detection of rare scattering events at keV energy threshold.

During the fellow, the candidate will take part to the design and characterization of the Optical Read Out technique based on Micro Pattern Gas Detector (MPGD) amplification of the ionization and on the visible light collection with a sub-millimeter position resolution sCMOS (scientific CMOS) camera. This type of readout - in conjunction with a fast light detection - allow on one hand to reconstruct 3D direction of the tracks, offering accurate sensitivity to the source directionality and, on the other hand, a high particle identification capability very useful to distinguish nuclear recoils.

Period: June-July or September-October 2019

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

Other Information:

- Accommodation: students may be accommodated in the LNF guesthouse, free of charge.
- LNF Summer closing period: 5-16 August 2019

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FRASCATI NATIONAL LABORATORY

LHCb 1

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

Description of the activity: LHCb is one of the main experiments 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 $B \rightarrow D^{(*)} \tau \nu_\tau$ (semi-tauonic) and $B \rightarrow D^{(*)} \mu \nu_\mu$ (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, and to explore different kinematic variables aiming to pin down the kind of New Physics that explains the observed anomalies.

We, in the LHCb group in Frascati, are 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 an 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 one the most important background that affects the semi-tauonic decays of the B mesons. This background, which is associated with the decays of orbitally and radially excited charm-meson states, is in fact much less relevant in B_s decays than in B decays. Moreover, semileptonic B_s decays offer many interesting kinematic observables that can be exploited to constrain various plausible New Physics scenarios.

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 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.

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

LHCb collaboration website for useful general information: <http://lhcb.web.cern.ch/lhcb/>;

Latest LHCb measurements on semi-tauonic B decays with many interesting links: <http://lhcb-public.web.cern.ch/lhcb-public/Welcome.html#RDst2>

A recent review about LFU: <http://inspirehep.net/record/1516196>

Period: 3 June - 2 August, 2 September - 31 October 2019

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

Other Information:

- Accommodation: students may be accommodated in the LNF guesthouse, free of charge.
- LNF Summer closing period: 5-16 August 2019

Local Exchange Program Contacts:

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FRASCATI NATIONAL LABORATORY

LHCb 2

Title: A fixed gas target for LHCb

Description of the activity: LHCb is one of the main experiments collecting data at the Large Hadron Collider accelerator. Among the several important features, its geometry and the advanced sub-detectors installed give several unique possibilities in the panorama of the high-energy physics. Indeed, LHCb is going to mount the first fixed gas target device ever installed on a high-energy collider like LHC. A storage cell, the only object present in the primary vacuum of the accelerator, will allow for beam-target collisions in synergy with the normal proton-proton collisions. All this will open to unique physics measurements in unexplored kinematic regions. The LHCb group in Frascati, having the leadership, is deeply involved in all the aspect, both technical and physical, of the project. The physics reach goes from the knowledge of the Parton Distribution Functions to the Quark Gluon Plasma, from the nucleon tomography to the astro-particle and dark matter, just to mention some of the possibilities. The setup will allow to inject several different types of gas from the lightest Hydrogen to the heaviest Xenon.

From one side, more instrumental effects like the embrittlement or the accumulation on the LHC triplets must be carefully studied by molecular flow simulations. From the other side the physics opportunities offered by this setup must be studied according to the running time and the specific gas injected. According to the interest and the skills of the student, as well as the development status of the project, there is the possibility to focus the studies on the first or the second item.

Period: 24 June - 30 August 2019

Tutor: Pasquale Di Nezza (pasquale.dinezza@lnf.infn.it)

Other Information:

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- LNF Summer closing period: 5-16 August 2019

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FRASCATI NATIONAL LABORATORY

CLAS12 RICH

Title: Study of the performance of the CLAS12 RICH

Description: The Jefferson Laboratory in Newport News (USA) is one of the leading facilities in the study of the internal structure of the nucleon. Here, high intensity and high polarization electron beams are scattered by hydrogen or nuclear targets, producing various particles in the final state. The accurate measurement of the rate and angular distributions of these particles allows to extract information on the quark and gluon structure of the nucleon. In the Hall B of the Jefferson Laboratory, the CLAS12 detector is able to perform these measurements over a wide kinematic acceptance.

A Ring Imaging CHerenkov (RICH) detector has been built by INFN to extend the particle identification capabilities of CLAS12 to kaons in the momentum range between 3 and 8 GeV/c. This will allow the CLAS12 to extend the study of the nucleon structure in kinematic regions otherwise not accessible.

The detector uses aerogel tiles as Cherenkov radiator, multi-anode photomultiplier tubes as photon detectors and a mirror system to collect as much as possible of the Cherenkov photons. The kaons are separated from the prevalent background of pions and protons by reconstructing the emission angle of the Cherenkov photons and studying the measured hit pattern. A likelihood approach is used to make the final particle identification.

Activity: The student will analyze the CLAS12 experimental data to study several important parameters that ultimately determine the RICH detector performance, as for example:

- the main characteristics of the RICH readout electronics, like the dark rate, the cross talk, the time-walk corrections;
- the study of the time resolution, that will allow to select in-time Cherenkov photons and to distinguish between photons detected directly from those detected after reflections on the mirrors;
- the mapping of the Cherenkov angle reconstruction as a function of the impact point on the aerogel radiator wall.

The student will develop dedicated algorithm to extract from the data the relevant information and to store them in the CLAS12 database.

Period: June-July 2019

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

Other Information:

- Accommodation: students may be accommodated in the LNF guesthouse, free of charge.
- LNF Summer closing period: 5-16 August 2019

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FRASCATI NATIONAL LABORATORY

PADME

Title: Search for dark matter signals at LNF with PADME

Description of the activity: There are models attempting to solve the dark matter problem, as well as the muon (g-2) anomaly, postulating the existence of a low-mass spin-1 particle (A') that would possess a gauge coupling of electroweak strength to dark matter, and a much smaller coupling to the Standard Model (SM) hypercharge. The PADME experiment, by using the positrons of the Frascati National Laboratory (LNF) LINAC, is searching for invisible decays of the dark photon by measuring the final state missing mass of the process $e^+e^- \rightarrow \gamma A'$, with the A' undetected.

The measurement requires the determination of the 4-momentum of the recoil gamma and the rejection of all possible source of background.

PADME is an international collaboration that comprises Bulgarian, Hungarian, Italian and American researchers. The detector has been installed on the LNF positron beam-line in 2018 and took data from October 2018 to February 2019. Now, an intense activity of data calibration and analysis is ongoing.

This is only the first phase of the experiment. There are plans to extend the physics program of the experiment to the search of other type of dark sector mediators such as long lived Axion-Like-Particles, proto-phobic X bosons, Dark Higgs.

Depending on the period of stay, the student will take part to the data taking activity, the calibration of the detector, and to the various analysis activities at the Frascati National Laboratory.

Period: June-July or September-October 2019

Tutors: Paola Gianotti (paola.gianotti@lnf.infn.it), Barbara Sciascia (barbara.sciascia@lnf.infn.it)

Other Information:

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- LNF Summer closing period: 5-16 August 2019

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FRASCATI NATIONAL LABORATORY

CarbonSEY

Research Field: R&D in Vacuum Science and Technologies

Title: Thickness dependence of SEY in thin film coated surfaces

Description of the activity: The Secondary Electron Yield, i.e. the number of electrons produced per incident electron of a given energy, is an ubiquitous problem in many fields of research, spanning from Accelerator to Spacecraft R&D. It is well known that two materials may have different values of SEY, determining their potentialities to be used in many applications. Moreover, the intrinsic SEY can be strongly modified by different atomic and molecular layers on the surface. What is not yet been studied is the thickness dependence of SEY and which is the minimum coverage of the overlayer that will grant the desired SEY. This project aims to address this issue by using all the surface science spectroscopies available in the laboratory, including Synchrotron Radiation, to study “in situ” thin Carbon films (known to have low SEY) onto different metal substrates (with higher SEY) to identify the thickness at which the SEY is dominated by the overlayer. Thermal, photo - and electron induced desorption will be studied from such surfaces and compared to the ones of other material generally used in accelerator technology.

Period: September-October 2019

Tutor: Roberto Cimino (roberto.cimino@lnf.infn.it)

Other Information:

- Accommodation: students may be accommodated in the LNF guesthouse, free of charge.
- LNF Summer closing period: 5-16 August 2019

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FRASCATI NATIONAL LABORATORY

NEMESYS 1

Title: NanoElectromagnetics (microwave/RF/phononics)

Description of the activity: 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.

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.

Period: June-July or September-October 2019.

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

Other Information:

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- LNF Summer closing period: 5-16 August 2019

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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

FRASCATI NATIONAL LABORATORY

NEMESYS 2

Title: Electron beam acceleration for advanced materials characterization

Description of the activity: 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).

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.

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

Period: June-July or September-October 2019

Other Information:

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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

FRASCATI NATIONAL LABORATORY

NEMESYS 3

Title: Nanosensors for biomedical applications

Description of the activity: 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 defense 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. 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 Vapor 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.

Period: June-July or September-October 2019.

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

Other Information:

- Accommodation: students may be accommodated in the LNF guesthouse, free of charge.
- LNF Summer closing period: 5-16 August 2019

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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

FRASCATI NATIONAL LABORATORY

F2S (StratoFly Accademy)

Title: Development of an FBG remote sensing device embedded in a metallic material

Description of the activity: The candidate is expected to join our group to learn how to use / operate FBGs and to propose innovative use of these fibers to be adopted and embedded in metallic materials. This activity is interdisciplinary and related to the StratoFly accademy, an H2020 Italian founded project. The candidate will run ANSYS simulations to estimate and calculate the coatings that the fibers would need to have in order to be protected, such coatings could be 3D printed with polymers. Finally the embedded could be constructed via a metallic 3D printing (inserting the protected fiber in the inside), or via traditional ways.

Period: Flexible from mid-May to mid-August 2019

Tutors: Luigi Benussi (LNF), Stefano Colafranceschi (Eastern Mennonite University, Harrisonburg VA USA) can work remotely as external student advisor

Other Information:

- Accommodation: students may be accommodated in the LNF guesthouse, free of charge.
- LNF Summer closing period: 5-16 August 2019

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FRASCATI NATIONAL LABORATORY

CMS

Title: Upgrade of the DAQ and analysis routing of the CMS GGM subsystem

Description of the activity: The GGM project was developed several years ago at LNF and installed at CMS Experiment in 2009. After almost a decade, the system needs a complete update of hardware and software to ensure its usability and maintainability for the next decade.

The candidate should be familiar with C++ coding and open minded to propose solutions that would fit into the complex CMS/DAQ environment. As the new hardware/electronics will be provided the activity would focus on the software update and efficient exploitation of the new hardware/electronics.

Period: Flexible from mid-May to mid-August 2019

Tutors: Stefano Bianco (LNF), Stefano Colafranceschi (Eastern Mennonite University, Harrisonburg VA USA) can work remotely as external student advisor)

Other Information:

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FRASCATI NATIONAL LABORATORY

TIDE

Title: TIDE: photon and electron sTImulated DEsorption: Its study and its impact to accelerator vacuum behaviour

Description of the activity: Electron and photon stimulated desorption from technical materials are essential input parameters to properly simulate vacuum behavior of new accelerators. Those parameters are even more important when analyzing accelerators that routinely use cryogenic components. Such cold surfaces will not be able to thermally desorb contaminant gasses. Only non-thermal processes (like electron and photon irradiation) may be inducing desorption and need full characterization. During this fellowship, the successful candidate will study electron desorption by using Secondary Electron Spectroscopy as recently proposed by the host laboratory, with the aim to help characterizing and calibrating the photon desorption station on small and cold surfaces which will be operating in the Frascati laboratory using synchrotron radiation produced by the DAΦNE storage ring or by external sources.

Period: June - July 2019

Tutors Roberto Cimino (roberto.cimino@lnf.infn.it)

Other Information:

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GENOVA

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 long shutdown of 2024-25 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. In particular, the Pixel detector collaboration has been performing R&D's to develop a detector able to fit the even more demanding conditions, such as larger radiation doses up to 2×10^{16} 1 MeV neq/cm². New sensors with smaller and thinner pixels have been part of this R&D. Genova, involved since 20 years in the ATLAS pixel detector, is working on the qualification of 3D sensors, a candidate technology for the innermost layer, and upgrades of the interconnections (bump-bonding, gluing) between the electronics and the sensors. Production of the ring support structures, loading of the pixel modules on the rings, development of a setup to test the devices is also part of the activity. The student will work in the Genova laboratory on these activities.

Recommend period: June-July or September-October

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

Local Secretariat: segreteria.direttore@ge.infn.it

GENOVA

EIC_NET

Title: Test of a triggerless data acquisition system for the Electron-Ion Collider

Description: Thanks to recent developments in computing and networking, the particle physics experiment trigger scheme based on FPGA is being replaced by streaming readout approaches, in which every detector channel is readout independently and all data above a minimum threshold are transferred to a CPU farm for further processing. This scheme has the advantage of simplifying the trigger implementation, since this can be developed using high-level programming languages (C++, JAVA, Python, ...), and of increasing the versatility of the system in adapting to diverse experimental conditions. During the stage, the student will participate in the validation tests of a prototype of a triggerless readout system designed for the readout of an electromagnetic calorimeter for the future Electron-Ion Collider in US. The experimental activity will include the optimization of the setup consisting of a matrix of PbWO₄ crystals, the streaming readout with commercial and custom digitizers, the data recording and processing with TRIDAS (TRIGGERless Data Acquisition System) and the implementation of different trigger conditions.

Recommend period: June - July 2019

Tutor: M. Battaglieri, A. Celentano

Local Secretariat: segreteria.direttore@ge.infn.it

GENOVA

JLAB12 - CLAS12

Title: Searching for exotic mesons with CLAS12

Description: Within the MesonEx experiment, we have built the Forward Tagger (FT), an extension of the CLAS12 detector at Jefferson Lab, composed by an electromagnetic calorimeter (FT-Cal), a hodoscope (FT-Hodo) and a tracker (FT-Trck). Using the FT, it is possible to produce an intense beam of quasi-real photon ideally suited to study both new and known light mesons. The physics analysis of the MesonEx program involves sophisticated partial wave analysis of the final states. To match the demanding requirements of the experiment, a full simulation-reconstruction chain for a specific reaction has been developed by using sophisticated computing tools, e.g. GPU, under the supervision of the theory group of INFN-Genova and in contact with the JPAC group at JLab. So far the analysis framework has been tested on simulations. After a engineering run in January 2018, the CLAS12 detector has completed the first data taking for physics. The student will have a chance to test the MesonEx framework with these data.

Recommend period: June - July 2019

Tutor: M. Battaglieri, R. De Vita

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GENOVA

JLAB12 - Light Dark Matter

Title: Light Dark Matter search at Jefferson Lab

Description: failure in direct observation of Dark Matter in the 10 GeV - 10 TeV mass range suggests to extend 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 Jlab12 Genova Group is leading the R&D program for the new Beam Dump eXperiment (BDX), which has been proposed at Jefferson Lab as new facility for light dark matter search. We are currently running some on-site tests to measure the muons produced in the dump by the 10 GeV high-current electron beam. The student will participate to the data analysis and the comparison to the simulations.

Recommend period: June - July 2019

Tutor: M. Battaglieri, A. Celentano

Local Secretariat: segreteria.direttore@ge.infn.it

GRAN SASSO NATIONAL LABORATORY

LUNA

Title: characterization of a neutron detector array for low energy nuclear astrophysics at LUNA

Description: in the framework of the LUNA project (Laboratory for Underground Nuclear Astrophysics) a renewed study of the $^{13}\text{C}(\alpha, n)^{16}\text{O}$ reaction is presently being carried out at LNGS. In this context also a dedicated neutron detector array has been developed and set up. The activities proposed here include the characterization of this detector array.

Recommended period: June-October 2019

Tutor: Csedreki László (laszlo.csedreki@lngs.infn.it), Alba Formicola (formicola@lngs.infn.it)

Local Secretariat: Vincenzo Fantozzi (useroffice@lngs.infn.it, fantozzi@lngs.infn.it)

LECCE

AUGER

Title: Test of front end boards for the AUGER experiment

Description: We can host a Student to work with Lecce team on the test and development of the AUGER new front-end board. The Local team is responsible for the development of the front and the DAQ.

The Upgraded Unified Board (UUB) version 3 will be available since June. The architecture of the UUB includes a Xilinx Zynq FPGA with two embedded ARM Cortex A9 333 MHz micro-processors, 4 Gbit LP-DDR2 memory and 2 Gbit Flash memory (storage memory). The processor manages several devices including front-end electronics, slow control, LED controller, GPS receiver, clock generator, memory and various connectors. The student activities will consist in testing the functionality of the new boards and develop specific applications to be implemented in the AUGER DAQ.

Recommend period: June – July 2019

Tutor: Prof. Giovanni Marsella

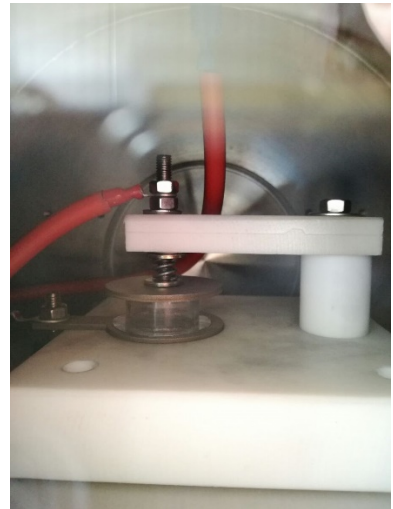
Local Secretariat: Lucia Sideli (lucia.sideli@le.infn.it)

LEGNARO NATIONAL LABORATORY

E-PLATE

Title: Electrostatic Powder pLating for Accelerator TargEts

Description: The E-PLATE project is devoted to R&D on High energy Vibration Powders Plating (HIVIPP) technique for accelerator target production starting from enriched powder materials. The main goal of project E-PLATE is to identify the reason of the thickness limitation of HIVIPP deposit and overcome it, in order to allow the preparation of the targets as for nuclear cross-section measurements (program-minimum), as for medical radionuclides production (program-maximum). The achievement of the E-PLATE project goals is planned through an extensive study of the factors that can cause the “saturation” effect in HIVIPP: powders size, powders oxidation level, substrate properties, the geometry of the deposition system and electric field parameters.



During this summer project we propose an opportunity to follow the experimental activity of the second year of the CSN5 of INFN project E_PLATE (financed for 2018-2019 as a Grant for young researchers, national responsible - Hanna Skliarova), including: preparation of the raw materials: powders (included metal cryomilling) and substrates, preparation of the experiment in a controlled atmosphere, deposition of the targets with E-PLATE system, analysis of the deposits (in a case of availability of corresponding infrastructures analysis by SEM, SEM-EDS, RBS with AN2000 accelerator).

Recommended period: September - October 2019, otherwise June-July 2019

Tutor: Hanna Skliarova

Reference of the local secretary: Luisa Pegoraro (luisa.pegoraro@lnl.infn.it)

Other information:

<https://www.researchgate.net/project/E-PLATE-Electrostatic-Powder-pLating-for-Accelerator-TargEts>

LNL Summer closing period August 4 - 29

Free lunch at LNL Canteen

LNL Free Guesthouse

Laboratory infrastructures involved E_PLATE electrostatic powders deposition system for target preparation (L 116).

LEGNARO NATIONAL LABORATORY

SPES 1

Title: Additive manufacturing for plasma ion sources

Description: Additive manufacturing for metallic high temperature materials (Ta, W, ...) at INFN: description of the general status and research of papers describing related R&D activities in the international community. Definition of a plasma source architecture capable to take advantage of the specific degrees of freedom related to additive manufacturing.

Recommended period: September - October 2019

Tutor: Mattia Manzolaro (mattia.manzolaro@lnl.infn.it)

Reference of the local secretary: Luisa Pegoraro (luisa.pegoraro@lnl.infn.it)

Other information:

LNL Summer closing period August 4 - 29

Free lunch at LNL Canteen

LNL Free Guesthouse

LEGNARO NATIONAL LABORATORY

SPES 2

Title: Production of gadolinium based refractory targets to produce terbium isotopes

Description: Production and characterization of gadolinium based targets (particularly gadolinium boride) by means of uniaxial pressing and sintering in a high vacuum furnace. Release and ionization of terbium (stable) isotopes in the SPES off-line front-end, to verify the capability of the gadolinium based target to sustain high temperature in high vacuum and to release Tb.

Recommended period: September - October 2019

Tutor: Stefano Corradetti

Reference of the local secretary: Luisa Pegoraro (luisa.pegoraro@lnl.infn.it)

Other information:

LNL Summer closing period August 4 - 29

Free lunch at LNL Canteen

LNL Free Guesthouse

MILANO

LHCb

Title: Fast tracking algorithms for the LHCb real-time data reconstruction

Description: In the LHC Run-3 phase LHCb will take data without a hardware trigger. The full data flow coming from the LHC interactions at 40 MHz will be processed by a computer farm called the High Level Trigger (HLT). The events will be reconstructed and filtered in real time in two steps by the HLT1 and HLT2. The student will be involved in the validation and implementation of the tracking algorithm.

Tutor:

Salvatore Aiola

Paolo Gandini

Nicola Neri

Recommended period: June-July or September-October

Other information: Institute will be closed in August

Local Secretariat:

Silvia Rognoni (silvia.rognoni@mi.infn.it)

PADOVA

LHCb 1

Title: Use of combined b -tag methods for b - and \bar{b} -jets identification in the forward region at LHCb exploiting deep-learning techniques

Description: The LHCb experiment at CERN has already demonstrated its capability of performing measurements with b -jets. With the upgraded detector, the experiment will have the possibility to collect a huge sample of jets important for several measurements like the b \bar{b} -asymmetry where new physics can manifest its self.

LHCb has the possibility to increase the capability to distinguish b -jets from \bar{b} -jets by combining the information of all the tagging methods therefore exploiting their correlations. Additional improvements can arise from the use of new computing algorithms based on deep learning techniques. The proposed project sees a student involved in the understanding of the b - and \bar{b} -jets properties. Thereafter, he/she will be involved in the training and optimization of a deep neural network using simulated data. Then, the algorithm will be applied to data collected during the current data taking to measure the performance.

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

- learn the concept of b - and \bar{b} - jet objects, how they are identified, the so called b -tag techniques;
- learn the deep neural network algorithm and its implementation in LHCb software;
- train the algorithm using simulated data to distinguish b - and \bar{b} -jets;
- apply the algorithm to collider data.

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

Recommend period: June-July September-October 2019

Tutor:

Donatella Lucchesi (donatella.lucchesi@pd.infn.it)

Lorenzo Sestini (lorenzo.sestini@pd.infn.it)

Local Scientific Secretariat:

Sandra Calore

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Local Theoretical Secretariat:

Paola Zenere

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email: zenere@pd.infn.it

PADOVA

LHCb 2

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 ($B^\pm \rightarrow K^\pm l^+ l^-$ and $B^0 \rightarrow K^{*0} l^+ l^-$) and in the semi-tauonic B meson decays ($R(D^*) = \mathcal{B}(B^{-0} \rightarrow D^{*+} \tau^- \nu_\tau^-) / \mathcal{B}(B^{-0} \rightarrow D^{*+} \mu^- \nu_\mu^-)$) by the BaBar, BELLE and LHCb experiments making this subject a very interesting research topic.

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 measurement of the ratio $R_{\Lambda_c(2625)} = \mathcal{B}(\Lambda_b^0 \rightarrow \Lambda_c^+(2625) \tau^- \nu_\tau^-) / \mathcal{B}(\Lambda_b^0 \rightarrow \Lambda_c^+(2625) \mu^- \nu_\mu^-)$. 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.

Recommended Period: June-July, September-October

Tutors: Simi Gabriele (gabriele.simi@pd.infn.it), Anna Lupato (anna.lupato@pd.infn.it)

Local Scientific Secretariat:

Sandra Calore

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Local Theoretical Secretariat:

Paola Zenere

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email: zenere@pd.infn.it

PAVIA

ATLAS

Title: Construction and Qualification of Micromegas detectors for the New Small Wheel upgrade of the ATLAS experiment

Description: Qualified students will participate in the construction of the Micromegas detectors for the upgrade of the ATLAS experiment in the New Small Wheel Project. Pavia is responsible for the construction and qualification of the readout part of one out of four Micromegas chambers. The students will be involved in QAQC of the detector component as well as in the data analysis of the data taken

Tutor: Gabriella Gaudio (gabriella.gaudio@pv.infn.it)

Recommended period: June 1st - August 3rd or September 2nd - October 31st

Other information:

Institute will be closed in August

Pavia offers a number of hosting opportunities in the University colleges

Local Secretariat:

Marina Ventura (marina.ventura@pv.infn.it)

PISA

NA62

Title: Control of digital testing devices for the Trigger and Data Acquisition system of the CERN experiment NA62

Description: A system of flexible, high-speed, digital pattern-generating electronic boards is being developed in Pisa in order to extensively exercise and test the Trigger and Data Acquisition system of the NA62 experiment at CERN, during the periods in which the beam is not available. The student is supposed to contribute to the design and implementation of the new control system and its user interface, to handle and program the boards on the field.

Recommended period: September-October 2019

Tutor: Gianluca Lamanna (gianluca.lamanna@pi.infn.it)

Local Secretariat:

Dr. Giacomo Betti

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email: giacomo.betti@pi.infn.it

PISA

VIRGO 1

Title: Advanced computing methods for gravitational wave physics

Description: The search for gravitational waves is being pursued at present with large interferometers in Europe and US. Virgo is the interferometric gravitational wave detector, located at the European Gravitational Observatory in Cascina (Pisa). The huge amount of data generated by gravitational wave interferometers provides a unique challenge that requires advanced analysis methods, including machine learning and deep learning. During the stay we will offer to the student the possibility to participate in the development of innovative deep learning algorithms for the analysis of gravitational wave data, with the possibility of tackling two main problems: the detection of gravitational waves from astrophysical transient sources and the fast, online characterization of the status and noise in the interferometer.

Recommended period: September-October 2019

Location: INFN Virgo Pisa Laboratory, Department of Physics at Pisa University (Pisa downtown)

Tutor: Massimiliano Razzano (massimiliano.razzano@unipi.it)

Local Secretariat:

Dr. Giacomo Betti

ph. +39 050 2214 270

email: giacomo.betti@pi.infn.it

PISA

VIRGO 2

Title: Development of low noise and high sensitivity rotational sensor for future Gravitational Waves detectors

Description: The INFN Pisa Group, deeply involved in the construction and continuous operation of the VIRGO and Advanced VIRGO interferometers 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.

In this contest a key role is played by new sensors to be included in the experimental apparatus for a feedback control use. Since the improved sensitivity of new generation detectors will require a more accurate measurements of the rotational acceleration to be distinguished from the translational one, a dedicated sensor for a pure tilt motion of the ground floor will be developed in this R&D program. The starting target sensitivity is set to 10^{-8} rad/sqrt(Hz) at 1 Hz with the intent to reach the same sensitivity down to 30 mHz. The new sensor is meant to be reasonably compact with low noise front-end electronics on board and Ultra High Vacuum compatible, so that it will be used inside a typical vacuum chamber maintained at a hydrogen partial pressure of the order of 10^{-7} mbar.

This task is considered very challenging for many aspects: the required sensitivity mentioned above, 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 on 6 degrees of freedom.

Recommended period: June-July or September-October 2019

Location: INFN Virgo Pisa Laboratory, Department of Physics at Pisa University (Pisa downtown)

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

Local Secretariat:

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PISA

VIRGO 3

Title: Validation of a parametric control strategy to decrease the resonance frequency of an inversed pendulum

Description: The INFN Pisa Group, deeply involved in the construction and continuous operation of the VIRGO and Advanced VIRGO interferometers 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.

An important point to be studied is the possibility of reducing the fundamental frequency of an oscillator without increasing its dimensions. If this is possible the improvement of attenuation performances will be obtained with a device of reasonable dimensions.

The theme of this activity is the characterization of a prototype inverted pendulum which uses a new parametric control technique to obtain a very soft oscillator. A small scale prototype will be characterized to validate the parametric control idea and to characteriza the noises which can be introduced.

Recommended period: September-October 2019

Location: INFN Virgo Pisa Laboratory, Department of Physics at Pisa University (Pisa downtown)

Tutor: Giancarlo Cella (giancarlo.cella@pi.infn.it)

Local Secretariat:

Dr. Giacomo Betti

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email: giacomo.betti@pi.infn.it

ROMA

CYGNO

Title: Advanced gas detectors for directional Dark Matter search

Description: CYGNO is a new proposal supported by INFN within the CYGNUMs proto-collaboration that aims at realizing a distributed observatory in underground laboratories for directional Dark Matter (DM) searches and the identification of the coherent scattering (CNS) of neutrinos from the Sun. CYGNO is one of the first prototypes in the road map to build a 10-100 m³ of CYGNUMs detector and it will be located at the National Laboratory of Gran Sasso (LNGS), in Italy. Its goal is to make significant advances in the technology of single phase gas-only time projection chambers (TPC) for the detection of rare scattering events down to a keV energy threshold.

During his/her stay in Rome, the candidate will join our group based at Sapienza University in Rome where we study the Optical Read-out technique based on the Gas Electron Multipliers (GEM) amplification of the ionization and on the visible light collection with a sub-millimeter position resolution sCMOS camera. The candidate will work on the optimization of a fast light sensor (SiPM or PMT) with laboratory measurements and data analysis.

Tutor:

Gianluca Cavoto (gianluca.cavoto@roma1.infn.it)

Davide Pinci (davide.pinci@roma1.infn.it)

Recommended period: June-July or July-August

Other information: <http://www.roma1.infn.it/summerstudents2019/summerstudent2019.html>

Scientific Coordinator:

Shahram Rahatlou (tel +390649914357 - email: shahram.rahatlou@roma1.infn.it)

Local Secretariat:

Mauro Mancini (tel. +390649914318 - email: mauro.mancini@roma1.infn.it)

ROMA TOR VERGATA

ATLAS

Title: Search for new physics in the dynamics of top quark events

Description: The ATLAS experiment is designed to study proton-proton collisions at the Large Hadron Collider. By the end of 2018, it has accumulated a dataset of about 140 fb⁻¹ of integrated luminosity at a center of mass energy of 13 TeV (Run-II). The student will investigate events of top-antitop pairs in the Run-II data, searching for anomalies in the decay chain of the top quark. Knowledge of ROOT or C++ and the basics of Unix are a plus.

Tutor: Lucio Cerrito (lucio.cerrito@cern.ch)

Recommended period: 1 June - 31 July

Other information: possibility of cheap accommodation.

Local Secretariat:

Carla Felici

ph. +39 06 7259 4570

email: carla.felici@roma2.infn.it

ROMA TOR VERGATA

VIRGO

Title: Instrument science for gravitational radiation detection

Description: The detection of gravitational waves from binary system has opened a new window to investigate our Universe. This research is done with large interferometers in Europe and US. Virgo is the interferometric gravitational wave detector, located at the European Gravitational Observatory in Cascina (Pisa).

The program will give the possibility to participate to the activity carried out in the Tor Vergata University, aimed to improve the detection capabilities of future gravitational wave observatories. The student will gain experience in the use and development of simulation tools and in experimental techniques for gravitational wave interferometry.

Tutor: Viviana Fafone (viviana.fafone@roma2.infn.it)

Recommended period: 1 June - 31 July

Other information: possibility of cheap accommodation.

Local Secretariat:

Carla Felici

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SOUTH NATIONAL LABORATORY

THEORY EXOTIC NUCLEI

Title: Understanding nuclear interaction for exotic nuclei and neutron stars

Description: The LNS theoretical group has developed a kinetic transport theory able to perform realistic simulations of the dynamics of heavy-ion collisions from Coulomb barrier energy up to intermediate energy. The approach allows one to investigate nuclear collective excitations (giant resonances), as well as fragmentation mechanisms associated with the liquid-gas phase transition and the occurrence of nuclear matter instabilities. In particular, the impact of an asymmetric neutro-proton content on the collisions dynamics and related observables is the main focus of the current activity. The interest is driven by the upcoming activity on nuclear reactions with exotic beams (SPES) and by nuclear astrophysics problems, such as the formation and the structure of neutron stars. The students will perform simulations of a particular process with the aim of a direct comparison with experimental data. The goal will be extracting information on the yet poorly known behavior of the nuclear symmetry energy at sub- or supra-saturation density.

Recommend period: June-July or September-October

Tutor: Maria Colonna (colonna@lns.infn.it)

Local Secretariat: Alessandra Falcomatà alessandra.falcomata@lns.infn.it

SOUTH NATIONAL LABORATORY

FARCOS

Title: Experimental activity with FARCOS

Description: the NEWCHIM group is involved in the construction and assembling of the FARCOS array (Femtoscope ARray for Correlations and Spectroscopy) constitute by 20 triple telescope: Double Sided Silicon Strip Detectors (DSSSD) as first (300 μm) and second (1500 μm) stages followed by CsI(Tl) crystals. The FARCOS, due to the high angular and energy resolution, will allow to probe the full time scale of the emission particles (from few fm/c to several hundreds of fm/c) and the spatial configuration shape of short mean life sources formed in Heavy Ion collisions at Fermi energy, through interferometric measurements. It will allow too to explore cluster structures in exotic nuclei produced by in-flight fragmentations FRIBs facility at INFN-South National Laboratory. Due to the large number of channels to be read, a digital acquisition and read-out is used in FARCOS, in particular the GET electronic.

During the stay the student will be engaged principally in experimental activities, participating in the mounting, tests on-beam and data analysis of the FARCOS modules.

Recommend period: June-July

Tutor: Francesca Rizzo (rizzo@lns.infn.it), Paolo Russotto (russotto@lns.infn.it), Giuseppe Cardella (cardella@ct.infn.it)

Local Secretariat: Alessandra Falcomatà alessandra.falcomata@lns.infn.it

SOUTH NATIONAL LABORATORY

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 multimessenger 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.

Recommend period: September-October

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

Local Secretariat: Alessandra Falcomatà alessandra.falcomata@lns.infn.it

SOUTH NATIONAL LABORATORY

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.

Recommend period: September-October

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

Local Secretariat: Alessandra Falcomatà alessandra.falcomata@lns.infn.it

TRIESTE

LHCb 1

Title: Exploring improved global fits of the electroweak precision observables

Description: This is a statistics/data analysis project targeted at exploring improved methods to test the consistency of the electroweak sector of the standard model of particle physics through global fits of the precision observables. Global fits of electroweak observables offer among the most solid experimental verification of the accuracy of our description of dynamics at the fundamental level. However, not all the effects of subtle correlations among some of the most powerful observables might have been included in detail in current fits. The student will develop a custom fitting framework and use publicly available experimental inputs to explore a novel approach that properly takes care of all correlations and will compare its performance with that of standard fits. The ideal candidate has an interest and some background in statistics and preferably some experience with multivariate fitting.

Tutor: Diego Tonelli

Recommended period: Preferably Aug 15- Oct 15 but earlier or later stays are possible

Other information: The INFN Trieste is open throughout summer, and the neighboring guesthouse offers an excellent and inexpensive accommodation option.

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

TRIESTE

LHCb 2

Title: A novel approach toward the measurement of the Lambda-b baryon lifetime

Description: This is a data analysis project targeted at the development of a novel method to measure the lifetime of the Lambda-b (Lb) baryon. The Lb lifetime is an important benchmark of the effective-field-theory methods used to calculate many observables associated with heavy-quark phenomenology. However, experimental results have long been puzzling as measurements based on different final states yield marginally consistent results. The student will use experimental and simulated proton-proton-collision data from the LHCb experiment at CERN to explore a novel approach based on semileptonic Lb and bottom-meson (B) decays into similar final states to measure the Lb lifetime relative to the B lifetime. The large size of semileptonic decay samples ensures high statistical precision, and usage of the well-known B lifetime as a reference allows for controlling the instrumental effects associated with partial reconstruction. The ideal candidate has an interest in experimental particle physics, data analysis, or both, and preferably some previous background with the usage of standard HEP data-analysis tools (Root)

Tutor: Diego Tonelli

Recommended period: Preferably Aug 15- Oct 15 but earlier or later stays are possible

Other information: The INFN Trieste is open throughout summer, and the neighboring guesthouse offers an excellent and inexpensive accommodation option.

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