Istituto Nazionale di Fisica Nucleare
AMMINISTRAZIONE CENTRALE
Direzione Gestione e Finanza
Divisione Reclutamento e Trattamento Economico
Ufficio Assegni di Ricerca, Borse di Studio e Contratti
D'Opera

ISTITUTO NAZIONALE DI FISICA NUCLEARE

AVVISO DI ANNULLAMENTO

Con provvedimento del Presidente n. 22009 del 27 marzo 2020 è stato disposto l'annullamento degli Avvisi di Selezione n. 21914/2020 e n. 21915/2020.

NOTICE

INFN has cancelled the following announcements:

n. 21914/2020 - n. 21915/2020

Istituto Nazionale di Fisica Nucleare
IL PRESIDENTE

Frascati, 27 marzo 2020

DISPOSIZIONE N. 22009

Il Presidente dell'Istituto Nazionale di Fisica Nucleare

- vista la disposizione n. 21914 del 25 febbraio 2020, con la quale è stato emesso l'Avviso di Selezione per il conferimento di n. 11 borse di studio a favore di giovani fisici statunitensi, previste dal programma di scambio estivo INFN-DOE "DOE-INFN Summer Student Exchange Program 2020 Edition" della durata di due mesi, da usufruire tra il 1° giugno e il 31 ottobre 2020, presso le Strutture INFN resesi disponibili;

- vista la disposizione n. 21915 del 2 marzo 2020, con la quale è stato emesso l'Avviso di Selezione per il conferimento di borse di studio a 4 studenti universitari che si rechino negli Stati Uniti come previsto dal Programma di scambio estivo INFN – NSF/LIGO per l'anno 2020 per un periodo di 10 settimane, indicativamente nel periodo compreso tra il 20 giugno e il 31 agosto 2020, sotto la supervisione di un referente-tutor italiano (ricercatore INFN o associato con l'INFN) e di un tutor statunitense;

- tenuto conto delle misure urgenti in materia di contenimento e gestione dell'emergenza epidemiologica da COVID-19 previste dal d.l. n. 6 del 23 febbraio 2020 e delle sue disposizioni attuative contenute in decreti del Presidente del Consiglio dei ministri, in modo particolare quelle previste nei d.p.c.m. dell'8 e 9 marzo 2020, nonché delle misure previste dal d.l. n. 18 del 17 marzo 2020 e dal d.l. n. 19 del 25 marzo 2020;

- considerato l'evolversi della situazione epidemiologica, il carattere particolarmente diffusivo dell'epidemia e le dimensioni sovranazionali del fenomeno nonché il fatto che anche gli Stati Uniti hanno adottato misure che limitano gli spostamenti allo scopo di contrastare e contenere il diffondersi del virus;

- ritenuto opportuno, in considerazione dello stato di emergenza e delle conseguenze dello stesso, provvedere all'annullamento degli Avvisi di Selezione 21914/2020 e 21915/2020 per l'annualità 2020;

DISPONE

1. di annullare gli Avvisi di Selezione di cui alle disposizioni del Presidente n. 21914/2020 e n. 21915/2020 in premessa per l'annualità 2020;

2. di dare incarico agli uffici competenti di pubblicare nel sito istituzionale dell'INFN apposito avviso di annullamento circa i suddetti Avvisi di Selezione;

3. di comunicare, a tutti i candidati che hanno presentato domanda sino alla data della presente disposizione, l'annullamento dell'Avviso di Selezione di riferimento.

SF/VC/ADV

ISTITUTO NAZIONALE DI FISICA NUCLEARE
Il PRESIDENTE
(Prof. Antonio Zoccoli)*

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

Istituto Nazionale di Fisica Nucleare
AMMINISTRAZIONE CENTRALE
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D'Opera

ISTITUTO NAZIONALE DI FISICA NUCLEARE – AVVISO DI SELEZIONE PER IL CONFERIMENTO DI N. 11 BORSE DI STUDIO A FAVORE DI GIOVANI FISICI STATUNITENSI, PREVISTE DAL PROGRAMMA DI SCAMBIO ESTIVO INFN-DOE "DOE-INFN SUMMER STUDENT EXANGE PROGRAM 2020 EDITION"

AVVISO DI RETTIFICA

Nell'Annex 1 dell'avviso di selezione n. 21914 del 25 febbraio 2020, è annullato il punto:

INFN Sections and Laboratories	Research Projects
8.LNGS	30. Development of SIPM-based Cryogenic Photodetectors

INVARIATO IL RESTO

Istituto Nazionale di Fisica Nucleare
IL PRESIDENTE

Frascati, 9 marzo 2020

DISPOSIZIONE N. 21963

Il Presidente dell'Istituto Nazionale di Fisica Nucleare

- vista la precedente disposizione n. 21914 del 25 febbraio 2020, con la quale è stato emesso un Avviso di Selezione per il conferimento di n. 11 borse di studio a favore di giovani fisici statunitensi, previste dal programma di scambio estivo INFN-DOE "DOE-INFN Summer Student Exchange Program 2020 Edition" della durata di due mesi, da usufruire tra il 1° giugno e il 31 ottobre 2020, presso le Strutture INFN resesi disponibili;

- visto l'Avviso di Selezione che prevede che i candidati possano effettuare n. 3 preferenze tra le 19 Strutture INFN e i 59 Progetti di Ricerca elencati nell'Annex 1;

- visto che il punto 30 dell'Annex1 riporta il Progetto di Ricerca "Development of SIPM-based Cryogenic Photodetectors" presso i Laboratori Nazionali del Gran Sasso;

-considerato che il Direttore dei Laboratori Nazionali del Gran Sasso in data 27 febbraio 2020, comunica che non garantisce la possibilità di accogliere eventuali assegnatari di borse di studio per il sopracitato Progetto di Ricerca;

- riconosciuta la necessità di provvedere;

DISPONE

1. Di annullare nell'Annex 1 dell'avviso di selezione n. 21914 del 25 febbraio 2020, il seguente punto:

INFN Sections and Laboratories	Research Projects
8.LNGS	30.Development of SIPM-based Cryogenic Photodetectors

2. che i candidati possono effettuare n. 3 preferenze tra le 19 Strutture INFN e i 58 Progetti di Ricerca elencati nell'Annex 1.

ISTITUTO NAZIONALE DI FISICA NUCLEARE

SF/VC/ADV

Il PRESIDENTE
(Prof. Antonio Zoccoli)[1]

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

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tel. +39 06 94031 – http://www.ac.infn.it - email: ac.dirpers.assegni-borse@lnf.infn.it
PEC: amm.ne.centrale@pec.infn.it

Announcement n. 21914

DOE-INFN Summer Students Exchange Program 2020 Edition

The US Department of Energy (DOE) and the Istituto Nazionale di Fisica Nucleare of Italy (INFN) announce the 2020 edition of the Summer Exchange Program dedicated to promote the exchange of students in science between the two countries.

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

We call for applications of US students willing to join a INFN research team in Italy for a two-month period between June 1st and October 31st, 2020.

There are 11 positions available. Applicants can choose among 19 different INFN sites and 59 research projects.

Grants amount to 5000 € to cover travel and living expenses. They are subjected to a 30% reduction due to Italian income taxes.

Eligible candidates must be enrolled as students at a US university and they must have begun, at the time of application, at least the third year of a US University curriculum in physics, engineering or computing science, or planning to start the third year in 2020.

Applications, in electronic form, must be sent to INFN not later than 27th March, 2020 (11.59 pm CET) through the website: https://reclutamento.infn.it/ReclutamentoOnline/

The application should include:

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

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

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

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

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

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

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

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

Rome, 25th February 2020

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

SF/VC/ADV

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

ANNEX 1

INFN Sections and Laboratories	Research Projects
1.Bari	1.Machine learning for the measurement of the cross section for the production of the Higgs boson in vector boson fusion topology
1.Bari	2.Configuration of a HEP analysis workflow in a Jupyter environment with the aid of GooFit and PROOF-Lite tools
2.Bologna	3.Commissioning of silicon detector qualification system The SAND system of the DUNE Near Detector
2.Bologna	4.The SAND system of the DUNE Near Detector
3.Cagliari	5.Studies of Heavy Nuclei collisions at LHCb
3.Cagliari	6.Argon purification with Aria and argon measurement with DART
4.Ferrara	7.Analysis of cosmic ray data from GEM detector readout by TIGER electronics and uTPC algorithm optimization.
4.Ferrara	8.Feasibility studies for the search for Zc(4430) in pi pi psi(2S)
4.Ferrara	9.The Ring Imaging Cherenkov (RICH) detector upgrade project of the LHCb experiment: R&D activities and characterization of fast-timing and radiation-hard single-photon detectors and electronics
5.Genova	10.Pixel detector for the ATLAS Upgrade at HL-LHC
5.Genova	11.Jet physics at the LHC
5.Genova	12.Searching for exotic mesons with CLAS12
5.Genova	13.Light Dark Matter search at Jefferson Lab
6.Lecce	14.Refurbishing of the KLOE calorimeter as Near Detector for the DUNE project
7.LNF	15.TIDE: photon and electron sTImulated DEsorption: Its study and its impact to accelerator vacuum behaviour
7.LNF	16.Desorption processes: analysis through SEY measurements
7.LNF	17.Kaonic atoms measurements with SIDDHARTA-2 to understand the strong interaction with strangeness at threshold
7.LNF	18.Convolutional neural network approach to particles identification in CYGNO experiment
7.LNF	19.Search for dark matter signals at LNF with PADME
7.LNF	20.Nanosensors for biomedical applications
7.LNF	21.Electron beam acceleration for advanced materials characterization
7.LNF	22.Study of b-hadron decays, a tool for New Physics discovery
7.LNF	23.Light dark matter searches with the KLOE-2 detector.
7.LNF	24.Towards testing Quantum Mechanics with neutral kaons at KLOE-2
7.LNF	25.High precision tests of low-energy QCD with fully neutral final states at KLOE-2
7.LNF	26.Data Management & Preservation at KLOE-2
7.LNF	27.Study of the performance of the CLAS12 RICH
7.LNF	28.Low Level RF control and fs laser synchronization
7.LNF	29.Accelerator magnet design
8.LNGS	30.Development of SIPM-based Cryogenic Photodetectors
8.LNGS	31.Detector and target characterization measurements in the framework of LUNA experiment
8.LNGS	32.The XENONnT Dark Matter Experiment
9.LNS	33.Isoscalar and Isovector excitation of the Pygmy dipole resonance in 68Ni
9.LNS	34.Characterization of the response of a miniaturized LAr TPC to low-energy nuclear recoils
9.LNS	35.Construction of the km3net high energy neutrino telescope at 3500 m depth offshore CapoPassero
9.LNS	36.Study of the performance of a Near Detector for the DUNE experiment at FNAL (USA)
9.LNS	37.Understanding nuclear interaction for exotic nuclei and neutron stars
10.Milano	38.Characterization of LGAD sensors for timing measurements at colliders
10.Milano	39.Upgrade and Qualification of the frontend electronics of the FARCOS telescopes
10.Milano	40.Development of a silicon tracking telescope to study particle channeling in bent crystals
11.Napoli	41.Nuclear reactions at Coulomb barrier energies finalized to the research on superheavy elements and exploration of the Terra Incognita
11.Napoli	42.Nuclear reactions at Coulomb barrier energies using the Radioactive Ion beams of the EXOTIC facility (Legnaro National Laboratories of the INFN, Padue)
11.Napoli	43.Measurement of the anomalous magnetic moment of the muon.
11.Napoli	44.Characterization of SiPM based Photon Detection Modules for the DarkSide Prototype.
12.Padova	45.Test of Lepton Flavour Universality with LHCb exploiting multivariate techniques
12.Padova	46.Efficient and fast c-jet identification at the LHCb experiment using quantum-based algorithms
12.Padova	47.Studies on the first events collected in the ICARUS T600 detector at FERMILAB
13.Pisa	48.Laboratory measurements campaign by using high precision and low noise sensors for future Gravitational Waves detectors.
13.Pisa	49.Machine learning techniques for gravitational wave physics
14.Roma	50.Dark-PMT - Dark Matter Detection with Carbon Nanotubes
15.Roma TorVergata	51.Instrument science for gravitational wave observation
16. Roma Tre	52.R&D on small pad Micromegas
17.Tifpa	53.Feature ranking in deep learning algorithms for HEP experiments
17.Tifpa	54.Characterization of irradiated silicon sensors
17.Tifpa	55.Electrical characterisation of fully depleted Monolithic Active Pixel sensors (MAPS)
18.Torino	56.Development of detectors for beam monitoring applications in particle therapy
19.Trieste	57.Search for short duration transient in Fermi/LAT data
19.Trieste	58.The GAPS experiment for dark matter exploration: development of particle identification algorithms
19.Trieste	59.Measurement of Bs0 → Ds(∗)−μ+ν form factors at the LHCb experiment

1.BARI

CMS – Title 1

Title: 1. Machine learning for the measurement of the cross section for the production of the Higgs boson in vector boson fusion topology

Description: The project consists of using machine learning techniques for the analysis of the data collected by the CMS experiment at the Large Hadron Collider (LHC) in order to derive an optimal discrimination of the signal for the production of the Higgs boson via a vector boson fusion mechanism, from the background. The final state includes two jets close to LHC beam line of the protons and a Higgs boson decaying in two Z bosons and then in four charged leptons. The student is asked to analyze the structure of the data and use them for the training of the machine learning algorithms both for the best configuration and for the best discrimination of the signal from the background. The usage of "deep neural networks", "artificial neural networks" and "boosted decision trees" techniques is foreseen. All the data collected by CMS during the Run2 will be analyzed in order to derive a measurement of the cross section of the production of the Higgs boson in the topology studied.

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

Recommended period: June 1 - July 31 or September 1 - October 31.

Other information: lodging in Campus residence.

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

1. BARI

CMS – Title 2

Title: 2.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.
Candidates are not requested to be already involved in the CMS experiment.
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

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

Recommended period: June 25th - July 31

Other information: Our group is also in contact with a student association which arranges accommodation for visiting students and professors.

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

2.BOLOGNA

ATLAS

Title: 3. Commissioning of silicon detector qualification system

Description: The Bologna ATLAS group is involved in the construction effort of the pixel part of the new inner tracker for ATLAS experiment (ITK). In particular Bologna group will test the hybrid modules (the sensor bonded to the front end chip) in its newly built clean room. The Hybrid pixel modules for ITK will be made by the bump bonding of a silicon pixel sensor (either in planar or 3D pixel geometry), and the new RD53 front end chip. The candidate for this project will be involved in the set up of the final testing system: she/he will participate in the set up of both the electrical and functional test of the modules, both at room temperature and cold environment, mechanical stress test using a climate chamber, and developing the software for analyzing the test results.
In particular she/he will have the opportunity to put together for the first time all the module testing chain in a newly built infrastructure.

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

Recommended period: June – July or September – October

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

2. BOLOGNA

The DUNE experiment

Title: 4. The SAND system of the DUNE Near Detector

Description: The SAND system is part of the DUNE Near Detector complex, based on the existing solenoidal superconducting magnet and electromagnetic calorimeter, to be complemented by tracking detectors and active targets in the inner magnetized volume. Studies are ongoing to finalize the design of the whole system. During her/his stay the student will be involved in the evaluation of the performance for the different detector configurations.

Tutors: Matteo Tenti (Matteo.Tenti@bo.infn.it)

Recommended period: June – July

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

Other information: There are several university student housings that can be checked for availability, but chances may be low.

3. CAGLIARI

LHCb

Title: 5. 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 1st or September 3rd - October 31st.

Other information: summer closure: 5-25th August 2020.

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

3. CAGLIARI

DarkSide

Title: 6. Argon purification with Aria and argon measurement with DART

Description: Aria is a cryogenic distillation plant under construction in Sardinia for purification of the argon for the DarkSide experiment at LNGS, Italy. The candidate is expected to take part in the analysis of data of this plant and make simulation studies. DART is a detector to be installed in LSC Spain for measuring argon radioactivity. The candidate is expected to take part in the analysis of data of this plant and make simulation studies.

[1] P. Agnes et al. (DarkSide Collaboration), Phys. Rev. Lett. 121 (2018) no.8, 08130
[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: Walter Bonivento (walter.bonivento@ca.infn.it)

Recommended period: June 1st – July 31st.

Other information: summer closure: 5-25th August 2020.

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

4. FERRARA

BESIII - CGEM

Title: 7. Analysis of cosmic ray data from GEM detector readout by TIGER electronics and uTPC algorithm optimization.

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

Tutors: Riccardo Farinelli – Gianluigi Cibinetto

Recommended period: June – July or September – October

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

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

Local web page: http://www.fe.infn.it/doe

4. FERRARA

BESIII

Title: 8. Feasibility studies for the search for $Z_c(4430)$ in pi pi psi(2S)

Description: Quantum Chromodynamics (QCD) is the theory that describes the strong interaction, the force that binds quarks and gluons into color-less hadrons. Mesons and baryons are the most conventional structures in nature, and plenty of candidates have been observed. However, the QCD allows more possibilities with more quarks and gluons bound together. The charmonium spectrum seems to be the ideal spot where to search for such structures since in recent years a set of unpredicted states has been observed above the DD* threshold. The first multiquark candidate in the spectrum was the Zc(4430), observed for the first time by Belle in the psi(2S)pi invariant mass in B → K psi(2S) pi and confirmed later by LHCb collaboration.
BESIII (Beijing Spectrometer III) is a multi-purpose central detector optimized for flavor physics. It has recently collected a new set of data between 4.6 and 4.7 GeV, thanks to an upgrade of the e+e- collider. With this new dataset, BESIII can try to search for this state in an almost background-free environment with respect to its competitors, possibly in combination with Y(4660), another unpredicted vector charmonium state. The candidate will be introduced to the BESIII physics and the charmonium spectrum, and he/she will learn how to perform a physics analysis starting from the MC simulation of the processes and the selection optimization of the signal over the possible backgrounds to show the expected performance of BESIII in such searches, before opening the real data.

Tutors: Isabella Garzia – Gianluigi Cibinetto

Recommended period: June – July or September – October

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

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

Local web page: http://www.fe.infn.it/doe

4. FERRARA

LHCb

Title: 9. The Ring Imaging Cherenkov (RICH) detector upgrade project of the LHCb experiment: R&D activities and characterization of fast-timing and radiation-hard single-photon detectors and electronics

Description: LHCb is one of the main experiments at the Large Hadron Collider (LHC) accelerator at CERN. Its primary goal is to study with high accuracy b and c quark decays to improve the knowledge of the Standard Model or to reveal the contributions of New Physics to the decay processes. One of the main features of the LHCb experiment is the capability to identify the particles produced in the final state. Several detectors are dedicated to this purpose. In particular the separation between pions, kaons and protons is provided by two Cherenkov imaging detectors (RICH-1 and RICH-2). The identification of muon particles is performed using a dedicated detector. LHCb is upgrading many of its sub-detectors during the Long Shutdown 2 (2019-2020): to cope with the luminosity increase the read-out electronics is being upgraded to 40 MHz and the detector geometry modified to reduce the occupancy. LHCb is proposing a Phase 2 Upgrade to take full advantage of the flavour physics opportunities at the High Luminosity LHC, operating from 2030 onward with a ten-fold increase in instantaneous luminosity compared to the Phase 1 upgrade ($1\text{-}2\times10^{34}$ $cm^{-2}s^{-1}$). The design of a very challenging RICH detector is being evaluated by the Collaboration and dedicated R&Ds have started, focused on high granularity single-photon detectors with excellent timing resolution (few tens of ps) and fast read-out electronics with time-stamping capabilities. The Ferrara University and INFN group is involved in both the RICH and Muon detectors.

Activities: The student, joining the Ferrara group in Summer 2020, will have the opportunity to participate to the different R&D activities: test and characterization of novel fast-timing single-photon detectors; test and characterization of front-end electronics; detector simulations.

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

Recommended period: June-July or July-August

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

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

Local web page: http://www.fe.infn.it/doe

5. GENOVA

ATLAS

Title: 10. 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 2025-26 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 2x10E16 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 constructiona and qualification of Pixel modules, in particular with 3D sensors, the technology for the innermost layer. 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.

Tutors: Claudia Gemme (claudia.gemme@ge.infn.it), Stefano Passaggio (Stefano.Passaggio@ge.infn.it)

Recommended period: June – July or September – October

Local Secretariat: Elisa Carnevali (elisa.carnevali@ge.infn.it)

5. GENOVA

LHC

Title: 11. Jet physics at the LHC

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

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

Recommended period: September – October

Local Secretariat: Elisa Carnevali (elisa.carnevali@ge.infn.it)

5. GENOVA

JLAB12

Title n.1: 12. Searching for exotic mesons with CLAS12
Title n.2: 13. Light Dark Matter search at Jefferson Lab

Description: The JLAB12 experiment includes all INFN-Italy activity at Jefferson Lab (US). The Genova Group is deeply involved in the MesonEx program, aiming for discovery of hybrid mesons, and in new experiments searching for light dark matter running at Jefferson Lab.

- Within MesonEx we have built the Forward Tagger (FT), an extension of the CLAS12 detector, 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. The CLAS12 detector is completing the first data taking for physics. The student will have a chance to test the MesonEx framework with these data, joining the ongoing Italian effort in the physics analysis of quasi-real photoproduction of a single pi0 on the proton.
- Search for physics beyond the Standard Model can be carried out with precise and GeV-energy-range experiments. 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 Genova Group is leading the R&D program for the new Beam Dump eXperiment (BDX) which is being proposed at Jefferson Lab as new facility for light dark matter search. We are currently running a mini version of the full experiment making use of the low energy and high intensity available during winter/spring 2020. The student will participate to the data analysis and the comparison to the simulations.

Within these frameworks we can provide two summer-student activities, one related to the Meson-Ex experiment and the other on Light Dark matter search. For further information see: http://www.jlab.org/Hall-B/clas12/

Tutors: Marco Battaglieri (marco.battaglieri@ge.infn.it), Andrea Celentano (andrea.celentano@ge.infn.it)

Recommended period: June – July or September – October

Local Secretariat: Elisa Carnevali (elisa.carnevali@ge.infn.it)

6. LECCE

DUNE at FERMILAB

Title: 14. Refurbishing of the KLOE calorimeter as Near Detector for the DUNE project

Description: DUNE is an ambitious project devoted to study the charge conjugation parity (CP) symmetry in the neutrino sector. This research may give the key to understanding why we live in a matter-dominated universe. The experiment will use Fermilab's powerful particle accelerators to send the world's most intense beam of high-energy neutrinos to DUNE's massive neutrino detectors. The Far Detector (FD) will be located in South Dakota at 1280 km from Fermilab. The Near Detector (ND) will be located 575 m far from the neutrino production at Fermilab. The ND must measure neutrino events as a function of neutrino flavor and energy. This allows for neutrino cross-section measurements to be made and constrains the beam model and the extrapolation of neutrino energy event spectra from the ND to the FD.
A component of the ND is the KLOE calorimeter. In the past KLOE was used in Italy to study kaon-phyics. Now it must be refurbished to be used in the SAND apparatus in DUNE-ND. In Lecce we are going to study its performances and possible improvements. The following are the activities (hardware and software) planned in Lecce:
- test on the fiber readout by means of silicon photomultipliers (SiPM) instead of the present phototubes
- mapping of present calorimeter efficiency and performances
- definition of possible triggers
- implementation of analysis algorithms

The summer student will be involved in some of these activities according to his/her inclination and skills.

Tutors: Marco PANAREO (marco.panareo@le.infn.it)

Recommended period: June - July

Other information: The LNS will be closed for two weeks in August (dates to be fixed). A guest house is available, more information at
https://www.lns.infn.it/en/pratical-information/guest-house.html

Local Secretariat: Gentile Carla (carla.gentile@le.infn.it)

7. LNF

TIDE /ARYA/GroupV-LdS

Title: 15. 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 DA□NE storage ring or by external sources.

Period: June – July 2020

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

Other information:
- Accommodation: students may be accommodated in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 10-21 August 2020

Local Exchange Program Contacts:
Catalina Curceanu (catalina.curceanu@lnf.infn.it) (coordinator)
M. Cristina D'Amato (secretary) Phone +39-06-94032373

7. LNF

DesorptionAnalysis/ARYA/GroupV-LdS

Research Field: R&D in Vacuum Science and Technologies

Title: 16. Desorption processes: analysis through SEY measurements

Description of the activity: Particular attention is recalled by the evolution of the dense molecular clouds, in which the low temperatures (10-20 k) allow the formation of elementary molecules ices on the dust grains in the innermost areas of the proto-planetary disks. The origin of the presence of more complex species, is thought to arise from a combination of surface chemistry and the evaporation of these molecular ices. The reasons of these desorption processes are found in thermal and radiative photo/electro desorption phenomena. In this work we want to study above all the second phenomenon, which is predominant in these environments, analyzing how the ice of simple molecules changes as a result of the thermal and energetic processes that arise through irradiation with electrons or photons. This survey, based on the measurement of surface parameters such as the secondary electron yield (SEY), can also influence other R&D areas, like the development of material for applications in vacuum chambers and particle accelerators.

Period: June – July 2020

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

Other information:
- Accommodation: students may be accommodated in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 10-21 August 2020

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7. LNF

SIDDHARTA-2

Title: 17. Kaonic atoms measurements with SIDDHARTA-2 to understand the strong interaction with strangeness at threshold

Description of the activity: The SIDDHARTA-2 experiment aims to perform the first measurement in the world of the X-ray transitions in the kaonic deuterium exotic atom, which will help to understand the strong interaction described by the Quantum ChromoDynamics (QCD) theory in the non-perturbative regime in systems with "strangeness" (i.e. with strange quarks). The SIDDHARTA-2 experiment will measure the X rays produced in the de-excitations of kaonic deuterium by using new Silicon Drift Detectors developed to perform precision X-ray spectroscopy and which can have applications going from physics and astrophysics to industry and medicine. SIDDHARTA-2 is in data taking at DAFNE, an electron-positron collider delivering kaons and 2020 is a very exciting period for the exp[eriment! 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 data taking and optimization of the setup on the DAFNE collider, one of the very few working colliders in the world, to data analyses and advanced Monte Carlo simulations, and will have the opportunity, unique in a lifetime, to see the first signal of kaonic deuterium ever!

Period: June – July or September – October

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

Other information:
- Accommodation: students may be accommodated in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 10-21 August 2020

Local Exchange Program Contacts:
Catalina Curceanu (catalina.curceanu@lnf.infn.it) (coordinator)
M. Cristina D'Amato (secretary) Phone +39-06-94032373

7. LNF

CYGNO

Title: 18.Convolutional neural network approach to particles identification in CYGNO experiment

Description of the activity: The CYGNO experiment (https://web.infn.it/cygnus/) aims to demonstrate the feasibility and capability of large gasses TPC for the identification of light dark mater candidates and very low energy solar neutrinos. The Particles are detected by means of high granularity and sensitivity sCMOS cameras. Inside the detected pictures, software algorithms have to identify signal candidates against natural radioactivity background, determinating the efficiency and energy threshold of the experiment. In this framework, the convolutional neuronal network could play a role in improving the today detector capability. The work will consist of studying and modeling a CNN approach to the analysis of the available data.

Period: June – July

Tutor: Giovanni Mazzitelli (giovanni.mazzitelli@lnf.infn.it) & Emanuele Di Marco (Roma1)

Other information:
- Accommodation: students may be accommodated in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 10-21 August 2020

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M. Cristina D'Amato (secretary) Phone +39-06-94032373

7. LNF

PADME

Title: 19. 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 missing mass of the process e^+e^- -> 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 and next data taking will take place from February 2020 till early summer.

Period: 1 June – 14 August

Tutor: Paola Gianotti (gianotti@lnf.infn.it), Fabio Ferrarotto (fabio.ferrarotto@roma1.infn.it)

Other information:
- Accommodation: students may be accommodated in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 10-21 August 2020

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7. LNF

Nanotechnologies NEXT – Title 1

Title n.1: 20. 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 defence etc. In spite of DNA – sensors already widely used in practice, they have a perspective for the improvement of functionality and cost – effectivity. One of the important directions in this matter is the increasing selectivity and sensitivity of sensors in expense of enhancement of electric signal and target – probe hybridization stability. Another important direction is the improvement of the electrode effectivity and manufacturability. From this point of view the best choice is the polymer – CNT enhanced nanocomposites, combining these two important features. At the same time, the better understanding of molecular mechanisms behind the DNA and RNA hybridization on the surface of electric transducer, and polymer – CNT nanocomposites formation is relevant for the improvement of effectivity and manufacturability of DNA – sensors. The Student will carry out all-round activity in nanoscience, with a specific calling for technological applications, stemming from scientific achievements and with the help of a careful theoretical research and modeling activity.
The Student will also participate to the realization of the Nanomaterial (e.g. carbon nanotubes and graphene) that are synthesized in the nanotechnology laboratory, and the corresponding biosensor nano-devices, which he will subsequently characterize and test. The student will engage in the Chemical Vapour Deposition of carbon nanotubes (CNT) and Graphene on catalytic substrates and/or in porous templates, as well as in the arc discharge synthesis of carbon nanotubes, without impurities and with a low density of defects. Purification and functionalization of carbon nanotubes are carried out by LNF team by physical and chemical methods.
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.

Period: June-July 2020.

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

Other information:

- Accommodation: students may be accommodated in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 10-21 August 2020

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7. LNF

Nanotechnologies NEXT – Title 2

Title n.2: 21. 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 participate to the Raman and Fourier Transform Infrared spectroscopies, and the Electron microscopy, electrical aand electronic characterizations of the nanomaterials, e.g. graphene, nanotubes, and epoxy nanocomposites. The Student will also 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 up to the microwave frequency range.
Main references:
1. "What does see the impulse acoustic microscopy inside nanocomposites?" VM Levin, YS Petronyuk, ES Morokov, A Celzard, S Bellucci, PP Kuzhir, Physics Procedia 70 (2015) 703-706
2. "Microstructure, elastic and electromagnetic properties of epoxy-graphite composites", SS Bellucci, F Micciulla, VM Levin, Yu S Petronyuk, LA Chernozatonskii, PP Kuzhir, AG Paddubskaya, J Macutkevic, MA Pletnev, V Fierro, A Celzard, AIP Advances 5 (2015) 067137
3. "Broadband Dielectric Spectroscopy of Composites Filled With Various Carbon Materials", Stefano Bellucci, Silvia Bistarelli, Antonino Cataldo, Federico Micciulla, Ieva Kranauskaite, Jan Macutkevic, Juras Banys, Nadezhda Volynets, Alesya Paddubskaya, Dmitry Bychanok, Polina Kuzhir, Sergey Maksimenko, Vanessa Fierro, Alain Celzard, IEEE Transactions on Microwave Theory and Techniques, 63 (2015) 2024-2031
4. "Nanocomposites of epoxy resin with graphene nanoplates and exfoliated graphite: Synthesis and electrical properties", A Dabrowska, S Bellucci, A Cataldo, F Micciulla, A Huczko, physica status solidi (b) 251 (2014), 2599-2602.
5. "Heat-resistant unfired phosphate ceramics with carbon nanotubes for electromagnetic application", Artyom Plyushch, Dzmitry Bychanok, Polina Kuzhir, Sergey Maksimenko, Konstantin Lapko, Alexey Sokol, Jan Macutkevic, Juras Banys, Federico Micciulla, Antonino Cataldo, Stefano Bellucci, physica status solidi (a) 211 (2014), 2580-2585
6. "Multi-walled carbon nanotubes/unsaturated polyester composites: Mechanical and thermal properties study", MSI Makki, MY Abdelaal, S Bellucci, M Abdel Salam, Fullerenes, Nanotubes and Carbon Nanostructures 22 (2014), 820-833

Period: June-July 2020.

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

Other information:
- Accommodation: students may be accommodated in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 10-21 August 2020

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7. LNF

LHCb

Title: 22. Study of b-hadron decays, a tool for New Physics discovery.

Description of the activity: One of the key assumptions of the Standard Model of fundamental particles is that the interactions of the charged leptons differ only because of their different masses. Recent studies of semileptonic decays of B-mesons have resulted in observations that challenge lepton universality (LFU) at the level of about three-four standard deviations. A confirmation of these results would point to the existence of new particles or interactions, and could have profound implications for our understanding of particle physics.
LHCb is one of the main experiments collecting data at the Large Hadron Collider accelerator at CERN. 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. The LFU test results obtained at LHCb concern so far two classes of transitions in b-quark hadron decays. Measurements of highly suppressed flavour-changing neutral-current decays, b → s ℓ^+ ℓ^−, hint at a difference involving muons and electrons, while measurements of the more frequent tree-level charged current processes, b → c ℓ^+ ν_ℓ, hint at a difference between muons and taus. These two classes of decays present very different challenges, both experimentally and theoretically.
In the LHCb group in Frascati we are deeply involved in several studies concerning b-hadrons, ranging from the study of LFU in semileptonic decays of the B_s mesons and \Lambda_b hadrons, to the study of the rarest B_s → \mu^+ \mu^- or B^0 → \mu^+ \mu^- decays.
Activities:
The student will be involved on key aspects of the data analysis. Depending on the chosen analysis, on his/her interests and when he/she will be with us, the work can focus on:
- the optimisation of signal selection and the study of a suitable sample to control the most dangerous backgrounds;
- the developments of novel algorithms to control efficiency determination;
- the improvements of the resolution of the signal kinematic useful for precise measurements of some observables.
The student will learn how to handle big sample of data with modern tools typically used in High Energy Physics. In particular, in various stages of the work, there
will be a large usage of modern Machine Learning techniques.
Some knowledges in computing (e.g. python, C++, root,...) are desirable but not mandatory.
Additional information:
LHCb collaboration website for useful general information:
http://lhcb.web.cern.ch/lhcb/
News about latest LHCb measurements on LFU (http://lhcb-public.web.cern.ch/lhcb-public/Welcome.html#RDst2 and
http://lhcb-public.web.cern.ch/lhcb-public/Welcome.html#RK2) and on the last update of B_s to \mu\mu
(http://lhcb-public.web.cern.ch/lhcb-public/Welcome.html#BsMuMu2017), all with many interesting links.
About LFU tests with B-decays:
https://cerncourier.com/a/beauty-quarks-test-lepton-universality/
http://inspirehep.net/record/1516196

Period: 3 June - 31 July 2020 or 1 September - 30 October 2020

Tutors: Marcello Rotondo (marcello.rotondo@lnf.infn.it),
Marco Santimaria (marco.santimaria@lnf.infn.it)

Other information:

- Accommodation: students may be accommodated in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 10-21 August 2020

Local Exchange Program Contacts:
Catalina Curceanu (catalina.curceanu@lnf.infn.it) (coordinator)
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7. LNF

KLOE-2 – Title 1

Title n. 1: 23. Light dark matter searches with the KLOE-2 detector.

KLOE-2
The KLOE-2 experiment completed its data taking campaign at the upgraded e+e- DAPHNE collider of the INFN LaboratoriNazionali di Frascati, at the end of Mach 2018, collecting more than 5 fb-1 at the center of mass energy of the phi-meson. The KLOE-2 collaboration activities are now focused on data reconstruction and analysis towards Precise Measurements and searches of Physics Beyond the Standard Model. The physics program is mainly focused on KS and eta meson rare decays as well as on kaon interferometry, fundamental symmetry tests and physics beyond the Standard Model, including searches for new exotic particles that could constitute the dark matter.

Description of the activity: The possibility to detect light dark matter in the sub-GeV regime through the decay of a light dark sector mediator is a unique opportunity for KLOE-2 which is presently hunting for the B-boson, a possible mediator of Dark Matter and Standard Model (SM) particles interaction. To this extent more than 5 fb-1 of data are available. The B-boson decay mimics the Standard Model known decays, therefore representing a challenge in analysis techniques to achieve a precise measurement of the upper limit on the coupling between dark and SM sectors in the sub-GeV mass range.
The summer student will participate in the ongoing analysis, contributing to the implementation of new approaches in calculating Upper Limits and applying Bayesian methods.
Basic knowledge in C++ and ROOT framework of CERN is welcome.

Period: June-July

Tutor: E. Perez del Rio (Elena.PerezDelRio@lnf.infn.it)

Other information:
- Accommodation: students may be accommodated in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 10-21 August 2020

Local Exchange Program Contacts:
Catalina Curceanu (catalina.curceanu@lnf.infn.it) (coordinator)
M. Cristina D'Amato (secretary) Phone +39-06-94032373

7. LNF

KLOE-2 – Title 2

Title n. 2: 24. Towards testing Quantum Mechanics with neutral kaons at KLOE-2

KLOE-2
The KLOE-2 experiment completed its data taking campaign at the upgraded e+e- DAPHNE collider of the INFN LaboratoriNazionali di Frascati, at the end of Mach 2018, collecting more than 5 fb-1 at the center of mass energy of the phi-meson. The KLOE-2 collaboration activities are now focused on data reconstruction and analysis towards Precise Measurements and searches of Physics Beyond the Standard Model. The physics program is mainly focused on KS and eta meson rare decays as well as on kaon interferometry, fundamental symmetry tests and physics beyond the Standard Model, including searches for new exotic particles that could constitute the dark matter.

Description of the activity: The entanglement in the neutral kaon pairs produced at the DAPHNE phi- factory is a unique tool to test discrete symmetries and the basic principles of quantum mechanics.
The decay phi → KSKL → $\pi^+\pi^-\pi^+\pi^-$ will be used among the others, significantly improving present results exploiting the insertion of a dedicated GEM-based tracking detector.
Both neutral kaons will decay within few cm from the interaction point, therefore detector performance in terms of spatial resolution and its stability along data taking are essential to better isolate signal selection and improve signal to background rejection. The student will participate in the development of dedicated algorithms to select 4-track final states and in the measurement of tracking and vertexing performance by studying different event topologies in the KLOE-2 detector and using the stability of Ks lifetime measurement as one of the figures of merit.
Basic programming skills are required.

Period: September-October

Tutor: Erika De Lucia (erika.delucia@lnf.infn.it)

Other information:
- Accommodation: students may be accommodated in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 10-21 August 2020

Local Exchange Program Contacts:
Catalina Curceanu (catalina.curceanu@lnf.infn.it) (coordinator)
M. Cristina D'Amato (secretary) Phone +39-06-94032373

7. LNF

KLOE-2 – Title 3

Title n. 3: 25. High precision tests of low-energy QCD with fully neutral final states at KLOE-2

KLOE-2
The KLOE-2 experiment completed its data taking campaign at the upgraded e+e- DAPHNE collider of the INFN LaboratoriNazionali di Frascati, at the end of Mach 2018, collecting more than 5 fb-1 at the center of mass energy of the phi-meson. The KLOE-2 collaboration activities are now focused on data reconstruction and analysis towards Precise Measurements and searches of Physics Beyond the Standard Model. The physics program is mainly focused on KS and eta meson rare decays as well as on kaon interferometry, fundamental symmetry tests and physics beyond the Standard Model, including searches for new exotic particles that could constitute the dark matter.

Description of the activity: The low-energy regime of the Quantum chromodynamics (QCD), characterizing strong interactions between quarks and gluons, is described by the Chiral Perturbation Theory (ChPT). This effective field theory is built as a series expansion in power of momenta. KLOE-2 could test with high precision theoretical predictions by measuring the eta -> pi0 gamma gamma decay channel.
In this ChPT "golden mode", the first two terms are suppressed, giving the possibility to test the theory at a very precise level. The student will participate in the analysis of fully neutral final states, focusing on the calorimeter performance by studying photon counting for different multi-photon decay channels.
Basic programming skills are required.

Period: September-October

Tutor: Simona Giovannella (simona.giovannella@lnf.infn.it)

Other information:
- Accommodation: students may be accommodated in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 10-21 August 2020

Local Exchange Program Contacts:
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M. Cristina D'Amato (secretary) Phone +39-06-94032373

7. LNF

KLOE-2 – Title 4

Title n. 4: **26. Data Management & Preservation at KLOE-2**

Description of the activity: Students with a background in Physics and/or Computer Science are warmly welcome to join the KLOE-2 Offline Group to participate in the development of monitoring tools, code optimization and algorithm design as well as data management, such as data preservation and storage.
Familiarity with programming languages like C++, Python, FORTRAN and Perl, together with different debugging tools and High Energy Physics frameworks, like ROOT from CERN, are desirable.
Particularly, we offer the possibility of joining the Offline Group in designing and implementing new algorithms more adapted to a new target language and newly installed KLOE-2 computing resources.
This gives a unique opportunity to improve/learn new programming skills and experience team work within a collaborative and friendly environment.

Period: June-July or September-October

Tutors: Fabio Fortugno (Giuseppe.Fortugno@lnf.infn.it), Paolo Gauzzi (paolo.gauzzi@roma1.infn.it)

Other information:
- Accommodation: students may be accommodated in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 10-21 August 2020

Local Exchange Program Contacts:
Catalina Curceanu (catalina.curceanu@lnf.infn.it) (coordinator)
M. Cristina D'Amato (secretary) Phone +39-06-94032373

7. LNF

The RICH of CLAS12/CLAS/JLAB12-LNF

Title: 27. Study of the performance of the CLAS12 RICH

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.

Description of the 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 mapping of the Cherenkov angle reconstruction as a function of the impact point on the aerogel radiator wall.
- the quality of the alignment of the planar and spherical mirrors by looking at photons detected in different topologies
- the optimization of the particle identification algorithm parameters, by looking at particular final states as elastic events or mesonic and baryonic resonances.

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 2020

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

Other information:

- Accommodation: students may be accommodated in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 10-21 August 2020

Local Exchange Program Contacts:

Catalina Curceanu (catalina.curceanu@lnf.infn.it) (coordinator)
M. Cristina D'Amato (secretary) Phone +39-06-94032373

7. LNF

SPARC_Lab

Title: 28. Low Level RF control and fs laser synchronization

Description of the activity: Measurement and calibration of RF systems for beam control and feedback in high brightness linear electron accelerators. Characterization of opto-electronics devices for laser-electron beam femtosecond synchronization in plasma wakefield acceleration experiments

Period: June 1st - August 14th or October 7th – November 6th 2020

Tutors: Luca Piersanti, Marco Bellaveglia

Secretary: ad.seg@lnf.infn.it

Other information:
- Accommodation: students may be accommodated in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 10-21 August 2020

Local Exchange Program Contacts:
Catalina Curceanu (catalina.curceanu@lnf.infn.it) (coordinator)
M. Cristina D'Amato (secretary) Phone +39-06-94032373

7. LNF

Accelerator Division

Title: 29. Accelerator magnet design

Description of the activity: Design of electromagnets to guide particle motion in accelerators based on the Poisson 2D simulation code

Period: June 1st - August 14th or October 7th – November 6th 2020

Tutors: Lucia Sabbatini, Alessandro Vannozzi

Secretary: ad.seg@lnf.infn.it

Other information:

- Accommodation: students may be accommodated in the LNF guesthouse (for information: http://www.lnf.infn.it/funz/concorsi/foresterie.html).
- Lunches at the LNF canteen (Monday-Friday) are free of charge.
- LNF Summer closing period: 10-21 August 2020

Local Exchange Program Contacts:
Catalina Curceanu (catalina.curceanu@lnf.infn.it) (coordinator)
M. Cristina D'Amato (secretary) Phone +39-06-94032373

8. LNGS

DarkSide

Title: 30. Development of SIPM-based Cryogenic Photodetectors

Description: The student selected will participate in the development of simulation and codes required for the test and development of new cryogenic photodetectors for the DarkSide-20k experiment, based on Silicon Photomultipliers.

Tutors: Thomas Thorpe

Recommended period: June – July

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

8. LNGS

LUNA

Title: 31. Detector and target characterization measurements in the framework of LUNA experiment

Description: In view of the installation of the new accelerator 3.5 MV LNGS facility at Gran Sasso Laboraroty, a complete study of the 14N(p,g)16O cross section study at high energy is foreseen. The grant period will be devoted to a detailed characterization measurements of the 14N solid target in terms of stability, purity and reproducibility through gamma detection using a HpGe detector. Basic software analysis will be developed.

Tutors: Alba Formicola <formicola@lngs.infn.it>

Recommended period: June – July

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

8. LNGS

XENONnT

Title: 32. The XENONnT Dark Matter Experiment

Description: The student will take part in the first data taking and analysis of the XENONnT direct Dark Matter search experiment and will participate in detector commissioning**.**

Tutors: Walter Fulgione walter.fulgione@lngs.infn.it
Marcello Messina marcello.messina@lngs.infn.it

Recommended period: June – July

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

9. LNS

NEWCHIM

Title: 33. Isoscalar and Isovector excitation of the Pygmy dipole resonance in 68Ni

Description: Data analysis of the Pygmy experiment scheduled in April 2020 at LNS.

Tutors: Francesca Rizzo (rizzo@lns.infn.it), Paolo Russotto (russotto@lns.infn.it)

Recommended period: September – October

Other information: The LNS usually is closed in the period 13-16 August ; a Guesthouse, a Dining room and TV room are available.

Local Secretariat: Stefano Romano (romano@lns.infn.it)

9. LNS

DarkSide

Title: 34. Characterization of the response of a miniaturized LAr TPC to low-energy nuclear recoils

Description: The ReD detector is a miniaturized dual-phase liquid argon (LAr) time projection chamber (TPC), which features all the innovative solutions developed for the DarkSide-20k design: in particular the optoelectronic readout based on SiPM developed by the Fondazione Bruno Kessler (FBK) and the cryogenic electronics. The response of such a LAr detector to very low-energy nuclear recoils (a few keV), possibly induced by a low-mass WIMP particle is poorly known and it would be extremely important in the light of the future DarkSide-20k program. A calibration of the TPC with low-energy nuclear recoils of known energy will be performed at INFN-LNS (Catania, Italy) by irradiating the detector with neutron sources; neutrons will interact with LAr by elastic scattering and produce Ar recoils. The recoil energy can be determined event-per-event, thanks to the two-body kinematics, by detecting the scattered neutron in a dedicated neutron spectrometer made by scintillators. Neutrons are produced by an intense ^{252}Cf fission source, which emits a Maxwell continuous spectrum up to 10 MeV. The energy of the primary neutron can be inferred event-by-event by using time-of-flight. The activity will include the calibration of TPC, firstly with standard gamma sources and then the measurement with the ^{252}Cf neutron source, and the corresponding data analysis.

Tutors: Luciano Pandola (LNS)

Recommended period: September – October

Other information: The LNS will be closed for two weeks in August (dates to be fixed). A guest house is available, more information at
https://www.lns.infn.it/en/pratical-information/guest-house.html

Local Secretariat: Stefano Romano (romano@lns.infn.it)

9. LNS

KM3NeT

Title: 35. Construction of the km3net high energy neutrino telescope at 3500 m depth offshore CapoPassero

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

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

Recommended period: September – October

Other information: The LNS will be closed for two weeks in August (dates to be fixed). A guest house is available, more information at
https://www.lns.infn.it/en/pratical-information/guest-house.html

Local Secretariat: Stefano Romano (romano@lns.infn.it)

9. LNS

Nu_at_FNAL

Title: 36. 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.

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

Recommended period: September – October

Other information: The LNS will be closed for two weeks in August (dates to be fixed). A guest house is available, more information at
https://www.lns.infn.it/en/pratical-information/guest-house.html

Local Secretariat: Stefano Romano (romano@lns.infn.it)

9. LNS

LNS Theory Group

Title: 37. 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.

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

Recommended period: September – October

Other information: The LNS will be closed for two weeks in August (dates to be fixed). A guest house is available, more information at
https://www.lns.infn.it/en/pratical-information/guest-house.html

Local Secretariat: Stefano Romano (romano@lns.infn.it)

10. MILANO

ATLAS

Title: 38.Characterization of LGAD sensors for timing measurements at colliders.

Description: Presently precise tracking devices determine time quite poorly while good timing devices are too large for accurate position measurement. This fact is imposing severe limitations on the potential of many applications ranging from medical positron emission tomography (PET) to mass spectroscopy or particle tracking. Recently RD50 collaboration has developed a single device able to concurrently measure with high precision the space (10μm) and time (10 ps) coordinates of a particle. In order to obtain the high signal-to-noise ratio (S/N) needed for ultra fast detectors (UFSD), the silicon sensors internal charge multiplication mechanism is exploited. Low Gain Avalanche Detectors (LGAD) technology is being considered and a time resolution better than 50 pico-seconds has been measured on sensors prototypes. In this project the most recent LGAD prototypes performance from different manufacturers will be characterised in terms of gain, leakage current and potentially capacitance before and after irradiation using dedicated laboratory equipment. UFSD are expected to play an important role in HEP by for example increasing the precision of time of flight (ToF) measurement in applications like mass spectroscopy or particle identification. Additionally, UFSD can improve particle tracking by suppressing random accidental coincidences in high-rate experiments as planned in High-Energy Physics. These improvements might also be beneficial for the pileup mitigation in the High Luminosity phase of the LHC when the average interactions per bunch crossing is expected to reach $<\mu>=200$.

Tutors: Leonardo Carminati, Ruggero Turra

Recommended period: June – July

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

10. MILANO

NEWCHIM

Title: 39. Upgrade and Qualification of the frontend electronics of the FARCOS telescopes

Description: FARCOS [1] is a novel Femtoscope Array for Correlation and Spectroscopy featuring high angular and energy resolution and able to address several open cases in nuclear physics. We (at INFN-Milano) are in charge of the development of the frontend electronics, power distribution system and interconnections. The frontend electronics is based on a multi-channel double-polarity selectable-gain VLSI frontend to be coupled to the Double-Sided Silicon Strip Detectors of FARCOS and to readout the signal of the photodiodes coupled to the CsI(Tl) scintillators acting as third detection stage. The student will collaborate in the upgrade and qualification of the 32-channel frontend boards, equipped with the ASICs, the line drivers and the slow-control and the readout of the scintillator detectors. In particular he/she will collaborate in the qualification of the assembled boards, assessing the performance of the system (linearity, energy resolution, cross-talk) and will take part in the design of the final version of the slow-control interface both for the frontend electronics and the power distribution system. The student will have the possibility to shape the focus of the research activity according to his/her skills and interests.
The student will have the possibility to work in a real research lab, with hands-on approach combined with a strong theoretical background in the field of radiation detectors and low-noise frontend electronics, sharing the daily lab life with PhD students, junior and experienced researchers.
Basic knowledge of analog electronics is preferred, no knowledge of nuclear physics is required.
[1] FARCOS TDR, available on-line:
https://drive.google.com/file/d/0B5CgGWz8LpOOc3pGTWdOcDBoWFE/view?usp=sharing

Tutors: Chiara Guazzoni (Chiara.Guazzoni@mi.infn.it)

Recommended period: June – July or September – October

Other information: August not available; Possibility of using Politecnico di Milano accomodation facilities (service has a fee)

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

10. MILANO

SELDOM/LHCb

Title: 40. Development of a silicon tracking telescope to study particle channeling in bent crystals

Description: The study of particle channeling in bent crystals requires very precise tracking information to select particles within the acceptance angle for channeling. The student will contribute to the test and characterisation of the silicon sensors and the front-end electronics in laboratory. In addition, by using simulated events, he/she will contribute to define the optimal setup for the test of bent crystals on beam.

Tutors Nicola Neri, Marco Petruzzo, Salvatore Aiola

Recommended period: June – July or September – October

Other information: August not available.

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

11. NAPOLI

FORTE

Title: 41. Nuclear reactions at Coulomb barrier energies finalized to the research on superheavy elements and exploration of the Terra Incognita

Description: The student will participate in the work of analysis of data gathered in experiments at several laboratories such as LNL (Padua, Italy), FLNR (Dubna, Russia) and JYFL (Jyvaskyla, Finland) and to the test of a new type of a position sensitive detector based on microchannel plate to be used in a time-of-flight spectrometer for fission fragments.

Tutors: Emanuele Vardaci

Recommended period: September – October

Local Secretariat: Maria Arienzo (Maria.Arienzo@na.infn.it)

11. NAPOLI

EXOTIC

Title: 42. Nuclear reactions at Coulomb barrier energies using the Radioactive Ion beams of the EXOTIC facility (Legnaro National Laboratories of the INFN, Padue)

Description: Direct measurement of reaction cross sections of ^{8}B, ^{7}Be and ^{6}Li on Silicon through the active target technique.
The student will participate in the work of simulation of the different nuclear processes taking place in the reaction ^{8}B,^{7}Be,^{6}Li+^{28}Si and in the data analysis. He will also have the possibility to perform some tests of the tracking detectors in our laboratory at Naples.

Tutors: Dimitra Pierroutsakou

Recommended period: September – October

Local Secretariat: Maria Arienzo (Maria.Arienzo@na.infn.it)

11. NAPOLI

Muon g-2

Title: 43. Measurement of the anomalous magnetic moment of the muon.

Description: The experiment Muon g-2 (E989), at Fermilab is in data taking since November 2017. The experiment aims to measure the anomalous magnetic moment of the muon with an improved experimental uncertainty, namely a factor 4 compared to the previous experiment E821 at BNL (i.e. 0.14 ppm). Inside the experiment the Italian INFN group has built the laser calibration system, providing stable reference signals to the 24 electromagnetic calorimeters.
The group of INFN - Naples is engaged the calorimeter SiPM gain monitoring and data analysis of omega_a. Given the high precision required to the system, a deep knowledge of the various uncertainty sources is requires. The activity foreseen within the scholarship will focus on the analysis of the calibration data. The activity will be in parallel to the data acquisition going on at Fermilab and the student will be able to actively participate in a very exiting phase of the experiment.

Tutors: Michele Iacovacci (Michele.Iacovacci@na.infn.it)

Recommended period: June – July or September – October

Other information: Possible cheap accommodation in B&B/Hostels in town centre and/or apartments shared with other students.

Local Secretariat: Maria Arienzo (Maria.Arienzo@na.infn.it)

11. NAPOLI

DarkSide

Title: 44.Characterization of SiPM based Photon Detection Modules for the DarkSide Prototype.

Description: The search for Dark Matter represents one of the most intriguing open frontiers in modern cosmology and astroparticle physics. The science case is extremely strong: observations of the cosmic microwave background fluctuations, large-scale galaxy surveys, studies of large scale structure formation and of the dynamics of galaxy clusters, all point to the existence of cold dark matter. Weakly Interacting Massive Particles (WIMP) are an excellent candidate for cold dark matter. These particles, predicted in many new theories extending beyond the standard model, may collide with ordinary nuclei via ultra-weak interactions, and could be detected by means of special, low-background detectors, capable of selectively identifying nuclear recoils - the likely signature of WIMP interactions.
The DarkSide Project for direct dark matter detection makes use of underground argon as a target in a two-phase time projection chamber, capable of achieving background-free conditions. The next step of the project carried out by the Global Argon Dark Matter Collaboration, counting over 350 members from 70 international Institutions, is a 1 ton prototype detector equipped with new SiPM-based cryogenic photodetectors.
The student selected will participate in laboratory activities for the test and characterization of the photon detectors for the DarkSide prototype, acquiring experience with noble liquid techniques, cryogenic systems, photosensors, low-background techniques, data read-out and acquisition, data analysis.

Tutors: Yury Suvorov

Recommended period: September – October

Local Secretariat: Maria Arienzo (Maria.Arienzo@na.infn.it)

12. PADOVA

LHCb - Title 1

Title: 45. 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 construc-tion and therefore any violation of it would be a clear sign of physics beyond the SM. Hints of non universality have already been observed in Electroweak Penguin processes and in the semi-tauonic B meson decays by the BaBar, BELLE and LHCb experiments making this subject a very interesting research topic.
The candidate will participate to the study of LFU with the LHCb detector through the study of b-Baryon decays. LHCb is in fact the only experiment that has the capability to study in detail these types of semileptonic decays and therefore to check the universality in the baryonic sector. The candidate will study in particular Λ_b semi-tauonic decays proceeding involving baryons aiming at the the measurement of the ratio $R_{\Lambda_c^*} = \mathcal{B}(\Lambda_b^0 \to \Lambda_c^{*+}\tau^-\bar{\nu}_\tau)/\mathcal{B}(\Lambda_b^0 \to \Lambda_c^{*+}\mu^-\bar{\nu}_\mu)$, where $\Lambda_c^{*+} = \Lambda_c^+(2595, 2625)$.
In the first part of the project the student will be involved in the study of the separation between signal and background for run2 data by means of multivariate classification algorithms exploring also the performance deep neural network classifiers. In the second part of the project, the student will refine a multidimensional fit algorithm to extract the semi-tauonic signal yield and perform simulated pseudo-experiment to determine the sensitivity of the signal extraction method.

Recommended Period: June-July, September-October

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

12. PADOVA

LHCb - Title 2

Title: 46. Efficient and fast c-jet identification at the LHCb experiment using quantum-based algorithms

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

The project is structured in different phases in which the student will:
- learn the concept of c-jet objects and how they are identified;
- learn the concept of classical machine learning with Deep Neural Networks and of quantum-inspired machine learning with Tensor Networks;
- apply the Tensor Network and Deep Neural Network to collider data and measure the efficiency and mis-identification rate;
- compare the inference time of the different methods.

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

Tutors: Lorenzo Sestini (lorenzo.sestini@pd.infn.it),
Donatella Lucchesi (donatella.lucchesi@pd.infn.it)

Recommended period: June – July or September – October

Local Secretariat: Laura Dal Fabbro

12. PADOVA

ICARUS - SBN

Title: 47. Studies on the first events collected in the ICARUS T600 detector at FERMILAB

Description: After a significant overhaul at CERN, the ICARUS T600 LAr-TPC detector has been moved at Fermilab and during this year will start again to take data exposed to the Booster Neutrino Beam (BNB) within the SBN program, to definitively clarify the open questions of the presently-observed neutrino anomalies hinting at the possible existence of sterile neutrinos. The T600 will take data at shallow-depth, exposed to a large flux of cosmic rays and a large number of cosmic muons is expected to cross the detector and randomly overlap each triggered event during its 1-ms drift time window. Neutrino interactions should be disentangled from the overlapping particles and recognized among the millions of events triggered by cosmics. It is then necessary to deploy suitable automatic tools for the identification, selection and measurement of the neutrino events and for the rejection of the incoming cosmic muons.
The student will be involved in the analysis of the first events collected during the commissioning. The student will first of all contribute to the validation and improvement of the event reconstruction tools. In addition the student will collaborate to the development and to the application and tuning of the tools needed for the calibration of the T600 detector. The focus will be in particular on the studies of the first collected neutrino interactions and on the exploitation of crossing cosmic muons in view of the detector calibration. The goal of the activities is to obtain a first evaluation of the event reconstruction efficiency for the neutrino interactions and for the cosmic rays and to extract from the cosmic muons the required information to calibrate in particular the TPC wire channels. The activity offers also to the student the unique opportunity to participate to the commissioning of a modern large-scale neutrino experiment and to gain a significant experimental experience.

Tutors: Daniele Gibin, Christian Farnese

Recommended period: September – October

Local Secretariat: Laura Dal Fabbro

13. PISA

VIRGO – Title 1

Title: 48. Laboratory measurements campaign by using high precision and low noise sensors for future Gravitational Waves detectors.

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

Tutors: F. Frasconi (franco.frasconi@pi.infn.it), A. Gennai (alberto.gennai@pi.infn.it)

Recommended period: September – October

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

13. PISA

VIRGO – Title 2

Title: 49. Machine learning techniques for gravitational wave physics.

Description: The search for gravitational waves is being pursued at present with large interferometers in Europe and US. Advanced Virgo is the interferometric gravitational wave detector, located at the European Gravitational Observatory near Pisa, Italy. The huge amount of data generated by gravitational wave interferometers provides a unique challenge for the development of fast, advanced analysis methods, in particular using 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.

Tutors: M. Razzano (massimiliano.razzano@unipi.it)

Recommended period: September – October

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

14. ROMA1

Dark-PMT

Title:50. Dark-PMT - Dark Matter Detection with Carbon Nanotubes

Description: By summer 2020 we will have the first working prototype of a Dark-PMT, a novel light Dark Matter detector based on aligned Carbon nanotubes that we are currently developing in University Rome Sapienza. The prototype will have to be calibrated, the background levels measured, and a first measurement will be done and interpreted in terms of Dark Matter constraints.

Tutor: Dr. Francesco Pandolfi (francesco.pandolfi@roma1.infn.it),
Prof. Gianluca Cavoto (gianluca.cavoto@uniroma1.it)

Recommended period: June - July

Local Secretariat: Mauro Mancini (mauro.mancini@roma1.infn.it)

15. ROMA 2

VIRGO

Title: 51. Instrument science for gravitational wave observation

Description: In the multi-messenger era, the detection of gravitational waves from astrophysical sources is a crucial observation channel of our universe. The operation of a network of detectors has effectively paved the way for this new window. 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, Italy). The proposed research program will give the possibility to participate to the experimental activity carried out in the Roma Tor Vergata University, aimed to improve the sensitivity of current and future gravitational wave detectors. The student will gain experience in simulation tools and innovative experimental techniques producing measurements and analyzing data.

Tutor: Elisabetta Cesarini (elisabetta.cesarini@roma2.infn.it)

Recommended period: June-July 2020 or September-October 2020

Local Segretariat: Carla Felici (carla.felici@roma2.infn.it)

16. ROMA3

MPGD

Project name: Micro-Pattern Gaseous Detectors (MPGD) for future experiments in High Energy Physics

Title: **52. R&D on small pad Micromegas**

Activity: The main goal of the project is the development of Micromegas detectors for particle detection at future colliders or for future LHC upgrades.
In order to achieve high rate capability with low occupancy, fine-segmented strips used in standard Micromegas detectors (e.g. in ATLAS) have been replaced by few mm2 pads.
An R&D is ongoing and several small size prototypes have been built showing promising results for operation up to a particle rate of tens MHz/cm2.
To guarantee smooth operation without discharges, several configurations of the resistive spark protection structure have been implemented.
The student will join the activities in the INFN laboratory of the University of Roma Tre, where new prototypes will be tested and characterized. He/she will learn how to operate the detectors and analyze the data in order to study the performance with different gas mixtures and operating conditions.

Proposed dates: June 1st – July 31st

Tutors: Roberto Di Nardo (roberto.di.nardo@cern.ch),
Mauro Iodice (mauro.iodice@roma3.infn.it),
Fabrizio Petrucci (fabrizio.petrucci@uniroma3.it)

Local Secretariat: Secretariat INFN Roma Tre - Filomena Foglietta
(filomena.foglietta@roma3.infn.it)

Additional information:
Università Roma Tre:
http://www.uniroma3.it

Dipartimento di Matematica e Fisica:
http://matematicafisica.uniroma3.it

INFN (National Institute of Nuclear Physics) Roma Tre:
http://www.roma3.infn.it

Accommodation Service University Roma Tre:
http://www.uniroma3.it/en/services/services-for-students/daily-life/accommodation-service

17. TIFPA

ATLAS

Title: 53. Feature ranking in deep learning algorithms for HEP experiments

Description: Deep learning is an everyday tool in High Energy Physics. It is used all across the data acquisition process, for online trigger, event reconstruction and data analysis. In this last case, signal is extracted from the overwhelming background by using hundreds of correlated observables, not all equally important. Feature ranking is a natural criterion to optimize Random Forest implementations, but it is less obvious when neural networks are considered. The student will join the DEEPPP group at TIFPA/FBK-ICT, working on pseudo-data of high energy pp collisions and implementing automated feature ranking tools for neural network optimization.

Tutors: Roberto Iuppa (roberto.iuppa@unitn.it)

Recommended period: June – July

Local Secretariat: Giuliana Pellizzari (giuliana.pellizzari@tifpa.infn.it)

17. TIFPA

ARCADIA – Title 1

(**A**dvanced **R**eadout **C**MOS **A**rchitectures with **D**epleted **I**ntegrated sensor **A**rrays)
https://indico.cern.ch/event/783429/contributions/3379667/attachments/1830545/2997979/20190416_ARCADIA_CEPC.pdf

Title: 54. Characterization of irradiated silicon sensors

Description: The ARCADIA project will target the development of a novel CMOS sensor platform allowing for active sensor thickness in the range 50 um to 300 um or more with pixel pitches ranging from 10 to 50um; operation in full depletion with fast charge collection only by drift; small charge collecting electrode for optimal signal-to-noise ratio; scalable readout architecture with ultra-low power capability (O(10mW/cm2)); easy compatibility with standard CMOS fabrication processes. The deliverable will be a full-size system-ready demonstrator of a low-power and high-density pixel matrix CMOS monolithic sensor to be used in high energy physics tracking detectors, astro-particle physics experiments as well as X-ray imaging and medical applications. During the so-called engineering run, test structures of pixel matrices and pseudo-strip sensors are produced.
In order to quantify the damage produced by total ionizing dose (TID) and non-ionizing energy loss (NIEL) on these structures, the selected candidate will perform in the fully equipped lab of the University of Trento (Department of Industrial Engineering), electrical characterization (capacitance-voltage and current-voltage measurements) on samples already irradiated with X-ray and 70-230 MeV proton beams available in the facilities located in the Trento area.

Tutors: Benedetto Di Ruzza INFN-TIFPA Trento & University of Trento:
benedetto.diruzza@tifpa.infn.it (office: +39 0461 283977)
https://webapps.unitn.it/du/en/Persona/PER0203448/Curriculum

Recommended period: September - October

Local Secretariat: Marta Perucci marta.perucci@tifpa.infn.it (office: +39 0461 282962)

Other information: INFN-TIFPA Trento: https://www.tifpa.infn.it/
University of Trento: https://www.unitn.it/en
Info about living in the Trento area: https://www.visittrentino.info/en
Info about the city of Trento: https://en.wikipedia.org/wiki/Trento
How to reach the city of Trento: https://www.comune.trento.it/Aree-tematiche/Turismo/Info-utili/Arrivare-a-Trento/(language)/eng-GB
Trento public transportation Info: https://www.trentinotrasporti.it/en/
Trento University, Physics Department Academic Calendar:
http://www.unitn.it/alfresco/download/workspace/SpacesStore/3c5beafb-7906-454a-b707-ecccad7e575c
Scientific Facilities partner of the INFN-TIFPA located in the Trento area:
Medical Proton Therapy Facility:
https://protonterapia.provincia.tn.it/eng/?/switchlanguage/to/protonterapia_eng
Research Center Fondazione Bruno Kessler (FBK):
https://www.fbk.eu/en/research-centers/

17. TIFPA

ARCADIA – Title 2

Title: 55. Electrical characterisation of fully depleted Monolithic Active Pixel sensors (MAPS)

Description: The ARCADIA project develops fully depleted MAPS for high energy, and astro particle physics experiments as well as X-ray imaging and medical applications. This wide range of applications and requirements is met by a new sensor design based on a modified 110nm CMOS process, which incorporates a low-doped n-type silicon substrate and includes backside processing. The p-n junction sits on the bottom of the sensor, thus the depletion region grows from backside surface with increasing bias voltage. Within the so-called engineering run, test structures of pixel matrices and pseudo-strip sensors with pixel pitches ranging from 10 to 50um and total thicknesses of 50 to 300um are produced by the foundry and will have to be electrically characterised by capacitance-voltage and current-voltage measurements. Additional measurements using an infrared laser to study the charge collection efficiency are important tools to evaluate the sensor design. The student will participate in the measurement campaign and work in the fully equipped lab of the University of Trento in the Department of industrial engineering.

Tutors: Coralie Neubüser (coralie.neubueser@tifpa.infn.it)

Recommended period: October - November

Local Secretariat: Marta Perucci marta.perucci@tifpa.infn.it (office: +39 0461 282962)

Other information: INFN-TIFPA Trento: https://www.tifpa.infn.it/
University of Trento: https://www.unitn.it/en
Info about living in the Trento area: https://www.visittrentino.info/en
Info about the city of Trento: https://en.wikipedia.org/wiki/Trento
How to reach the city of Trento: https://www.comune.trento.it/Aree-tematiche/Turismo/Info-utili/Arrivare-a-Trento/(language)/eng-GB
Trento public transportation Info: https://www.trentinotrasporti.it/en/
Trento University, Physics Department Academic Calendar:
http://www.unitn.it/alfresco/download/workspace/SpacesStore/3c5beafb-7906-454a-b707-ecccad7e575c
Scientific Facilities partner of the INFN-TIFPA located in the Trento area:
Medical Proton Therapy Facility:
https://protonterapia.provincia.tn.it/eng/?/switchlanguage/to/protonterapia_eng
Research Center Fondazione Bruno Kessler (FBK):
https://www.fbk.eu/en/research-centers/

18. TORINO

MoVeIT – (Detectors for medical applications)

Title: 56. Development of detectors for beam monitoring applications in particle therapy

Description: Thin silicon detectors with internal low gain (Ultra Fast Silicon Detectors - UFSD) are a promising technology for monitoring the high flux proton beams in clinical applications. They feature very fast charge collection time, good signal-to-noise ratio and excellent time resolution.
Our group has developed two prototypes of detector based on UFSD: one able to count the single particle for measuring the beam flux and the second one for the measurement of the beam energy exploiting time-of-flight techniques.
According to her/his background and interest, the student will have the opportunity to choose among several activities: characterization of silicon sensors, laboratory tests, programming, data acquisition software development and data analysis. She/he will have the opportunity to perform experimental tests with clinical proton beams at the Italian centers of particle therapy (CATANA in Catania, CNAO in Pavia and Proton Therapy Center in Trento).

Tutors: Simona Giordanengo (simona.giordanengo@to.infn.it),
Anna Vignati (anna.vignati@to.infn.it)

Recommended period: June – July or September – October

Other information: August not available; accommodation suggestion:
https://www.edisu.piemonte.it/en/services/scholarships-and-other-grants/accommodation-service

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

19. TRIESTE

FERMI

Title: 57. Search for short duration transient in Fermi/LAT data

Description: the student will partecipate in the data analysis of Fermi/LAT data to search and characterize transient events, possibly associated to GRB, FRB and GW events.

Tutors: prof. Francesco Longo (francesco.longo@ts.infn.it)

Recommended period: June – July

Other information: INFN Trieste benefits from the very convenient Area guesthouse where short and medium-term visitors are accommodated in single-occupancy studio-apartments with kitchenette and restroom at a very fair price

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

19. TRIESTE

GAPS

Title: 58. The GAPS experiment for dark matter exploration: development of particle identification algorithms

Description: The General Antiparticle Spectrometer (GAPS) is designed to carry out a sensitive dark matter search by measuring low-energy cosmic-ray antiparticles, with a focus on antideuterons and antihelium nuclei.
Unlike other indirect signatures of dark matter annihilation or decay, antinuclei, especially antideuterons, benefit from promising DM signals and strongly suppressed astrophysical backgrounds. GAPS is planned to fly three times on a long-duration balloon over Antarctica with the first flight planned for the austral summer of 2021. In the first flight, GAPS will be able to perform the most precise measurement ever made of the cosmic antiproton flux below 250 MeV, as well as a sensitive search for antideuterons.
The detection principle of the experiment relies on the identification of the antiparticle annihilation pattern. Low energy antiparticles slow down in the apparatus, they are captured in the medium to form exotic excited atoms, which de-excite by emitting characteristic X-rays. Afterwards they undergo nuclear annihilation, resulting in a star of pions and protons. The simultaneous measurements of the velocity, stopping depth and the dE/dx loss of the primary antiparticle, of the X-ray energies and of the star particle-multiplicity provide very high rejection power that is critical in rare-event search.
Beyond antiparticles, GAPS will be able to detect other more common cosmic ray particles (e.g. protons and antideuterons) that will be used for studies of cosmic ray propagation in the galaxy and in the heliosphere.
For all these analysis, particle identification is a critical issue. Various techniques of particle identification are under study. The student will participate to the development of techniques that uses both classical and machine-learning approaches.

Tutors: Riccardo Munini (riccardo.munini@ts.infn.it)

Recommended period: September - October

Other information: INFN Trieste benefits from the very convenient Area guesthouse where short and medium-term visitors are accommodated in single-occupancy studio-apartments with kitchenette and restroom at a very fair price

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

19. TRIESTE

LHCb

Title: 59. Measurement of $B_s^0 \to D_s^{(*)-}\mu^+\nu$ form factors at the LHCb experiment

Description: this is a data analysis project targeted at the measurement of the decay rates of $B^0 \to D^{(*)-}\tau^+\nu$ and $B^0 \to D^{(*)-}\mu^+\nu$ decays. Such rates offer a powerful probe for lepton-flavor-universality violation (LFUV) , which can be induced by several Standard-Model extensions and attracted recently significant attention due to recently observed excesses of semi-tauonic decays with respect to semi-muonic decays at the B factories and LHCbl. LHCb has the unique opportunity to also search for LFUV in semileptonic B_s^0 decays. The goal of the project is to achieve a first, but essential step toward this search by measuring for the first time the form factors of the $B_s^0 \to D_s^-\mu^+\nu$ and $B_s^0 \to D_s^{*-}\mu^+\nu$ decays, using the proton-proton collision data collected by LHCb in 2011-2018. Form factors are empirical functions that describe the hadronic portion of the decay amplitude and represent also valuable inputs for many other measurements, such as B_s^0 branching fractions. The student will work on experimental and simulated LHCb data to learn how to select a sample enriched in signal, study its reconstruction efficiency, background contamination, and devise strategies to extract the form factors from a simultaneous maximum likelihood fit of several distributions.

Tutors: Mirco Dorigo and Diego Tonelli

Recommended period: June – July or September - October

Other information: INFN Trieste benefits from the very convenient Area guesthouse where short and medium-term visitors are accommodated in single-occupancy studio-apartments with kitchenette and restroom at a very fair price

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