MASTER THESIS proposals 2018-2019

PATH 1: EXPERIMENTAL

1. ANALYSIS OF THE BREAKUP CHANNEL OF THE 7LI+119SN SYSTEM AT ENERGIES AROUND THE COULOMB BARRIER

Universidad de Sevilla, Spain

Supervisors: Juan P. Fernández García (jpfernandez@us.es) (University of Seville, Spain)
Pierpaolo Figuera (figuera@lns.infn.it) LNS-INFN (Catania, Italy)

Abstract:

Elastic scattering and inclusive breakup measurements of the nuclear reaction 7Li+119Sn at 21.2 and 26.5 MeV were performed at the LNS-INFN laboratory (Catania, Italy).

The aim of this work is to understand and analyse reactions induced by weakly bound nuclei, in particular the 7Li+119Sn reaction, in order to obtain the experimental inclusive breakup cross-sections of the fragments coming from the 7Li dissociation into alpha plus triton.

These experimental data will be compared with the predictions of calculations based on the inclusive breakup model.

2. STUDY OF THE TUNNELING EFFECT IN NUCLEAR PHYSICS THROUGH MEASUREMENT OF HEAVY ION FUSION; CONSEQUENCES FOR ASTROPHYSICS

LNL-Padova
Supervisors: G. Montagnoli (montagnoli@pd.infn.it),
A.M. Stefanini (alberto.stefanini@lnl.infn.it)

Abstract:

the probability of compound nucleus formation in collisions between heavy ions at energies near the Coulomb barrier has shown many interesting features as the large influence of nuclear structure on the probability of quantum tunneling. We propose to the student to participate in an experiment dedicated to nuclear fusion where cross sections will be measured at decreasing energies with respect to the barrier for the system 12C + 24Mg. The experiment will be performed at the Laboratori Nazionali di Legnaro of INFN. The student will take care of the analysis of collected data, in order to extract the fusion cross sections, as well as of their theoretical interpretation within present models using coupled channel calculations.

These measurements allow to obtain detailed information on the shape of nuclear potential, so to explain the interesting phenomenon known as "fusion hindrance", that is a limitation of fusion recently observed at very low energies. The obtained results are relevant from the point of view of astrophysics, because the cross sections determine the rate of nuclear reactions within the stars and therefore their lifetime.

3. STUDY OF THE N=50 SHELL CLOSURE USING RADIOACTIVE ION BEAM

Supervisors: Andrea Gottardo (andrea.gottardo@lnl.infn.it),
Jose Javier Valiente-Dobon (javier.valiente@lnl.infn.it)

Abstract:

the Master thesis project of the involved students will be based on two experiments likely to be performed at ISOLDE (CERN) this autumn. It concerns the physics around the N=50 neutron shell closure. These two experiments will exploit radioactive beams of 70Ni and 79Zn to study shell structure and shape coexistence on this region of the nuclide chart, respectively. The 70Ni beam will be used to perform one neutron transfer reactions on a deuterated target at the centre of the arrays MINIBALL (for gamma spectroscopy) and T-REX (for particle spectroscopy). The angular distribution of the emitted particles, in coincidence with gamma rays, will enable one to deduce the shell structure at the shell gap. The 79Zn beam will be delivered to a gold target at the centre on the Miniball array for Coulomb excitations. The intensity of the detected gamma rays will help to assess the coexistence of different nuclear shapes in the same nucleus.

The student will be involved in the analysis of the measurements, learning the basis of gamma and particle spectroscopy to extract energies and angular distributions of excited states. He will also become acquainted with the instruments at the forefront of modern nuclear research.

4. ATS: AN ACTIVE TARGET AT SPES

Supervisor: Tommaso Marchi (tommaso.marchi@lnl.infn.it)

Abstract:

Active targets are tracking detectors working as Time Projection Chambers (TPCs) where the detection gas is, at the same time, the target for the Nuclear Reaction of interest. This brings important advantages in terms of luminosity and allows to exploit the lowest intensity beams. An obvious application of this technology is in the field of Nuclear Structure and Reactions using Radioactive Ion beams where the most exotic species are produced and post-accelerated with intensities down to 10^3 pps. The proposed activity is related to the development, construction and commissioning of an Active Target to be used at the SPES facility of Legnaro National Laboratories (INFN, Italy).

The master student will contribute to the detector's characterization with radioactive sources and to the data taking of in-beam tests with stable beams. He will develop algorithms for particle tracking and GEANT4 simulations. He will also contribute to the data analysis of energy loss experiments that are planned for late 2018 using different ions (^{1}H -^{120}Sn) on different gases (iC4H10, CF4, CH4, D2, H2)

5. R&D ON DOPING PROCESSES OF HYPERPURE GERMANIUM FOR GAMMA RADIATION DETECTORS

Supervisor: Gianluigi Maggioni (gianluigi.maggioni@lnl.infn.it)

Abstract:

The activity is focused on the study of the surface doping of hyperpure germanium crystals, achieved by using a suitable doping element deposited on the Ge surface with a vacuum deposition technique and on the characterization of the surface and electrical properties of the doped crystals. This is an activity of Experimental Physics, in particular Solid State Physics and Semiconductor Physics applied to the R&D of gamma radiation detectors

6. NEUTRON SPECTRA MEASUREMENTS FOR NUCLEAR ASTROPHYSICS

Supervisor: Pierfrancesco Mastinu (mastinu@lnl.infn.it)

Abstract:

the Lenos project, actually running at CN accelerator of the LNL, has the goal to produce maxwellian neutron spectra at kT ranging from 8 to 90 keV thermal temperature. This spectra is the same of stellar interior, where elements heavier than iron are synthetized in the so called s-process. We developed a new method for the production of maxwellian neutron energy distribution (see ref. Appl Radiat Isot. 2012 Aug;70(8):1583-9.) but the stellar spectra at different kT must be measured and well characterized. The thesis will deal with the preparation of the experiment, the run and the subsequent data analysis.

7. ISOSPIN SYMMETRY BREAKING IN MIRROR NUCLEI 71KR – 71BR.

Supervisors: F. Recchia (francesco.recchia@pd.infn.it)
S.M. Lenzi (lenzi@pd.infn.it)

Abstract:

Energy differences between excited states in mirror nuclei (with exchanged number of protons and neutrons), the so-called Mirror Energy Differences (MED), give the possibility to highlight several nuclear structure properties. Systematic studies have been performed with remarkable success in the *sd* and $f_{7/2}$ shells, while the experimental information in the upper *fp* shell is still scarce. Shape coexistence in the region may give rise to different shapes even in mirror nuclei, strongly influencing the MED.

The student will take part in the analysis of an experiment performed at the GANIL laboratory, France, using the AGATA tracking germanium array coupled to the NEDA neutron detector. The student is expected to take charge of one of the reaction channels performing the analysis and comparing the result to the most recent theoretical calculations.

8. SHAPE COEXISTENCE IN ^{68}SE.

Supervisors: S.M. Lenzi (lenzi@pd.infn.it),
F. Recchia (francesco.recchia@pd.infn.it)

Abstract:

The interplay of different nuclear shapes is well established around A~70. It is a consequence of the presence of large gaps at both oblate and prolate deformation.

In order to study the development of deformation as a function of angular momentum, an interesting case is ^{68}Se that presents the coexistence of two rotational bands at low excitation energy. The ground-state band has been proposed to correspond to an oblate shape while the yrare band is suggested to be prolate deformed and to become yrast at $J^{\pi}=8^{+}$. Theoretical calculations in the *fp* and *fpg* model spaces predict pure configurations at low spin but large discrepancies are found for between calculations performed with different effective interactions.

The student will join the group in the analysis of ^{68}Se nucleus produced in a fusion-evaporation reaction. The student will learn the analysis techniques used for the measurement of lifetime of excited states, in particular using Doppler Shift Attenuation Method.

9. CHARACTERISATION OF THE DETECTORS AND DATA ACQUISITION SYSTEM OF THE GALILEO PHASE II GERMANIUM ARRAY.

Supervisor: F. Recchia (Francesco.recchia@pd.infn.it)

Abstract:

The Galileo project consists in the construction of the high-efficiency gamma-ray spectrometer that will be the main apparatus for the radioactive beams of the SPES facility at the Legnaro National Laboratories. The first SPES beams will be extracted in 2019 and the Galileo detectors will be used for the study of the beta decay of these beams.

The upgrade of Galileo, namely the phase II of the project, will make use of both single tapered germanium detectors as well as new triple cluster germanium detectors. The construction of the phase II will be ultimated by the end of 2018.

The student will test the new detectors and characterize them both in terms of resolution and efficiency. The student will study the response of the daq at high count rate. In addition, the student will develop an algorithm for compensating charge collection in radiation damaged detectors.

10. A NEW TISSUE EQUIVALENT PROPORTIONAL COUNTERFOR HADRONTHERAPY

Supervisor: Valeria Conte (valeria.conte@lnl.infn.it)

Abstract:

Radiation therapy with protons and carbons is gaining popularity and interest all over the world because of the favorable depth-dose distribution (Bragg peak) and enhanced radiation effectiveness, with respect to photon, electron and neutron radiotherapy. At present, sixty-four therapeutic centers worldwide use particle beams to treat their patients. Most of them use fast protons beams and ten centers (3 in Europe, 5 in Japan and 2 in China) use carbon ions. A definite model of radiation action on living cells is still unestablished, however it is known that the absorbed dose (the mean energy imparted to matter per unit mass) is not sufficient to characterize the biological effect, in that equal doses of different radiations lead to different results. The absorbed dose, being a macroscopic quantity, cannot describe the stochastics of the interaction processes produced by incoming radiation with the target medium. However, the capability of ionizing radiation to damage a living cell is closely related to the local interactions within relevant subcellular structures, like the chromosomes.
An accurate treatment planning should therefore take into account the particle interactions at the micrometer level. To this respect, microdosimetry offers a valuable technique, by measuring the stochastics of energy deposition in small volumes of approximately 1 m size. Tissue-equivalent gas proportional counters (TEPC) are the reference devices.

A miniaturized TEPC has been built at the Legnaro National Laboratories of INFN, to cope with high intensity therapeutic beams used, for instance, at the Centro Nazionale di Adroterapia Oncologica (CNAO) of Pavia. The objective of the thesis is to design, construct and test a novel simplified mini-TEPC, optimized for the clinical environment. The simplifications will concern the mechanical design, the gas filling and flowing system, the control and Data-acquisition system.

11. NUCLEON EXCHANGE IN HEAVY ION COLLISIONS

Supervisors: G. Montagnoli (montagnoli@pd.infn.it)
A.M. Stefanini

Abstract:

The thesis is concerning the heavy ion collisions and in particular the nucleon exchanges that take place on semi-classical trajectories at energies in the vicinity at the Coulomb barrier. The measurements will be performed at Legnaro National Laboratory, using the PRISMA magnetic spectrometer to detect and identify the reaction products.

Important information can be obtained on the pairing interaction responsible for the formation of nucleon pairs, in analogy to the Cooper pairs in solid state physics, which are responsible for phenomena as superfluidity and the "Josephson effect". For example our group has recently performed an experiment of this kind on the system ^{206}Pb(projectile) + ^{118}Sn(target).

The student will participate in the next measurements and in the first part of data analysis. He will also be able to compare the results with the predictions of existing models.

12. THE 22NE(P,GAMMA)23NA REACTION IN NOVAE AND SUPERNOVAE EXPLOSIONS

Supervisors: Rosanna Depalo,
Carlo Broggini (broggini@pd.infn.it)

Abstract:

The ^{22}Ne(p,γ)^{23}Na reaction takes part in the neon-sodium cycle of hydrogen burning and it has a stronginfluence on the synthesis of neon and sodium isotopes in several astrophysical scenario. In particular, at the typical energies of classical nova and supernova explosions the ^{22}Ne+p cross section is dominated by a large number of poorly-known resonances. In order to reduce the uncertainty on such reaction, an experiment has been performed at the Helmholtz – Zentrum Dresden – Rossendorf (HZDR), Germany. The goal of the experiment is to determine the strengths of most intense resonances of the 22Ne+p reaction with unprecedented high precision, exploiting gamma spectroscopy techniques. The student will perform a complete analysis of the data acquired at HZDR and evaluate the impact of the new results on the astrophysical reaction rate.

13. INVESTIGATION OF THE MOLECULAR STRUCTURES IN ^{21}NE BY MEASURING THE SPECTROSCOPIC FACTOR IN K=1/2,3/2 BANDS

Supervisor: Daniele Mengoni (daniele.mengoni@lnl.infn.it)

Abstract:

The thesis work is dedicated to the analysis of commissioning experiments of the MUGAST set-up at ALTO. MUGAST is a Silicon array covering backward and 90 deg. angles designed for stripping reactions measurements in combination with the AGATA gamma array and the VAMOS spectrometer at GANIL. The campaign is foreseen in 2019 at GANIL. The Silicon detectors will be commissioned at ALTO through two different experiments detailed below.

In particular the experiment aims at studying molecular states in 21Ne, where alpha clusters are bond together by sharing a "covalent" neutron. Clustering is a universal phenomenon that goes also beyond nuclear physics, and its comprehension is therefore of the utmost importance and large impact.

The proposal aims at the quantitative determination of the clusterization by measuring the alpha spectroscopic factor of the molecular states in 21Ne. The nucleus will be populated by a transfer reaction of a 17O beam on a LiF target. The evaporated deuteron detected in MUGAST will carry information on the populated states and their nature.

14. MEASUREMENT OF D0-MESON PRODUCTION IN PROTON-PROTON AND PB-PB COLLISIONS AT THE LHC WITH ALICE

Supervisor: Marcello Lunardon (marcello.lunardon@pd.infn.it)

Abstract:

The student will analyse recent data samples collected with ALICE (A Large Ion Collider Experiment) at the LHC, with the goal of measuring and characterise the production of the D0 meson, a particle containing a charm quark, in Pb-Pb collisions. Heavy quarks are among the most useful probes to investigate the properties of the Quark-Gluon Plasma formed in ultra-relativistic heavy-ion collisions. They are produced in hard-scattering processes with high-momentum transfer in the early stages of the collisions, before the formation of the QGP. Therefore, by interacting with the medium quarks and gluons, they witness the whole evolution of the expanding and cooling systems. Therefore, the study of the kinematic properties of D-mesons, the final-state hadrons that contain charm quarks, allows to retrieve information on the microscopic interactions occurring in the QGP and thus on the properties of the medium itself.

The D0 is the lightest particle with a charm quark and is particularly well suited for the study of charm production. The goal of the thesis is to measure the D0 production and its kinematic properties (transverse-momentum spectrum, azimuthal anisotropy) via the

reconstruction of its decay into a charged pion and kaon. To this purpose the decay topology should be studied in order to best exploit the excellent spatial resolution and particle-identification capabilities of the ALICE detector.

With the foreseen work of thesis, the student will have the opportunity to learn and practice with some of the fundamental techniques used to reconstruct unstable particles in particle physics. She/he will get familiar with invariant mass analyses, particle-track reconstruction and particle-identification techniques in modern detectors at accelerators, event selection, analysis on grid network, and other concepts that are fundamental ingredients for researchers in high-energy particle and nuclear physics. The usage of multi-variate analysis techniques and neural network can also be considered, especially for the removal of the fraction of D0 mesons coming from the decay of particles with beauty quarks.

15. KAONIC ATOMS EXPERIMENTAL STUDIES AT THE DAFNE COLLIDER[1]

LNF, Italy

Supervisor: Dr. Catalina Curceanu, Spokesperson of the SIDDHARTA-2 collaboration- catalina.curceanu@lnf.infn.it

Abstract:

The Master Student will be involved in the data taking of the SIDDHARTA-2 experiment at the DAFNE collider, aiming to perform the first kaonic deuterium measuremen[1]t ever. This measurement will be used to extract, in collaboration with theoreticians, the antikaon-nuclei isosipn-dependent scattering lengths and to investigate the impact in astrophysics - in particular in the equation of state of neutron stars.
The Master Student will receive training in experimental sector - as Silicon Drift Detectors - in data analyses, Monte Carlo simulations and will be actively involved in the main phases of the experiment and in the contacts with theoreticians for data interpretation

[1] A co-supervisor of the thesis in University of Padova or University of Catania is required in this master thesis topic. In case you are interested in this topic, please contact Prof. Giovanna Montagnoli (U. Padova) montagnoli@pd.infn.it or Prof. Stefano Romano (U.Catania) romano@lns.infn.it.

16. LASER SPECTROSCOPY OF THE HEAVIEST ELEMENTS[2]

GSI Helmholtzzentrum für Schwerionenforschung GmbH

Supervisor: Prof. Dr. Michael Block; M.Block@gsi.de

Abstract:

We are developing a new setup for high-resolution laser spectroscopy in a gas jet. To this end, we are building a new gas cell in which the ions of interest are stopped and neutralized. The extracted neutral atoms are then laser ionized. The goal is to perform (hyperfine) laser spectroscopy to determine nuclear spins, magnetic moments and quadrupole moments. The main task is to help putting the setup together and preforming commissioning experiments to characterize the performance."

[2] A co-supervisor of the thesis in University of Padova or University of Catania is required in this master thesis topic. In case you are interested in this topic, please contact Prof. Giovanna Montagnoli (U. Padova) montagnoli@pd.infn.it or Prof. Stefano Romano (U.Catania) romano@lns.infn.it.

17. MASS SPECTROMETRY:

GSI Helmholtzzentrum für Schwerionenforschung GmbH[3]

Supervisor: Prof. Dr. Michael Block; M.Block@gsi.de

Abstract:

We are presently developing a setup for single-ion mass measurements of the heaviest elements to study their nuclear structure. To this end, we are designing a new Penning trap setup and cryogenic amplifiers and tank circuits. The main task is to develop and characterize electronics components including amplifiers and supercomputing coils for the setup. In addition, software for the data acquisition and analysis has to be programmed. Alternatively, improvements to the SHIPTRAP setup are being implemented. In order to perform high-precision mass measurements of very heavy rare isotopes we are working on improving the stability of the SHIPTRAP setup further. Since the magnetic field is changing dependent on the temperature and the pressure we plan to improve the actives stabilization systems. The impact of this will be characterized by offline mass measurements of stable and long-lived nuclides that are relevant in the context of nuclear astrophysics and for neutrino physics.

[3] A co-supervisor of the thesis in University of Padova or University of Catania is required in this master thesis topic. In case you are interested in this topic, please contact Prof. Giovanna Montagnoli (U. Padova) montagnoli@pd.infn.it or Prof. Stefano Romano (U.Catania) romano@lns.infn.it.

18. Experimental investigation of the neutron induced ^{7}Be(n,α)^{4}He reaction for application to the cosmological lithium problem

DFA-University of Catania – Italy / INFN-LNS (Catania, Italy)

Supervisors: Livio Lamia: llamia@lns.infn.it
Stefano Romano: romano@lns.infn.it

Abstract:

Lithium puzzle is one the most intriguing unsolved problem at our days. Its predicted abundance by CMB evaluations is generally accepted to be a factor about 3 higher than the one deduced by halo stars. However, recent observations in Pop.II stars tend to predict a higher value of primordial lithium thus possibly alleviating the Li-problem. In this charming scenario, the reaction rate determination for both the producing and the destruction channels involving lithium are really necessary in order to reduce the corresponding uncertainties. In particular, the role of the unstable ^{7}Be during the early epoch of the Big Bang Nucleosynthesis is currently matter of study in view of the long-standing ^{7}Li cosmological problem. Recently, the Trojan Horse Method (THM) has been applied for measuring the cross section of the ^{7}Be(n, α)^{4}He reaction channel via a devoted THM study. The experiment has been also performed at INFN-LNL (Legnaro, Italy) by using an in-flight produced 7Be beam impinging on a CD_2 target. Deuteron has been used as "THM nucleus" in the ^{2}H(^{7}Be, α α)p quasi-free reaction ignited at a beam energy of 20 MeV. The data analysis will consist in the calibration of the DSSSD (double sided silicon strips detectors) adopted in the experimental setup as well as the extraction of the two-body reaction cross section of interest. This will be the key ingredient for evaluating the impact of the THM result on the cosmological scenario.

19. EXPERIMENTAL INVESTIGATION OF THE 27Al(p,α)24Mg REACTION TO CONSTRAIN 27Al AND 26Al/27Al GALACTIC ABUNDANCES

LNS (Catania, Italy) / DFA-University of Catania - Italy

Supervisors: Marco La Cognata: lacognata@lns.infn.it
Stefano Romano: romano@lns.infn.it

Abstract:

The 27Al(p,α)24Mg reaction cross section is presently very poorly known, making the nucleosynthesis of Al and Mg very uncertain. In particular, in the field of multimessenger astronomy a very important role is played by 26Al, a tracer of nucleosynthesis sites in our Galaxy. In meteorites, the ratio of the abundance of its daughter 26Mg to 24Mg and 27Al is recovered, so it is crucial to know with high precision the nucleosynthesis process not only of 26Al but also of 27Al and 24Mg. Therefore, we have measured the 27Al(p,α)24Mg cross section down to astrophysical energies using an indirect approach called Trojan Horse Method, using a deuteron to transfer a proton and induce the 27Al(p,α)24Mg unhindered by Coulomb barrier. The aim of the work will be to carry out energy and position calibration of charge-partition position sensitive detectors and perform 28Si spectroscopy, looking for unobserved resonances at deep sub-Coulomb energies that may radically change present-day nucleosynthesis scenarios.

20. EXPERIMENTAL INVESTIGATION OF THE 3He(n,p)3H REACTION FOR THE BBN NUCLEOSYNTHESIS

LNS (Catania, Italy) / DFA-University of Catania - Italy

Supervisors: Rosario Gianluca Pizzone: rgpizzone@lns.infn.it
Stefano Romano: romano@lns.infn.it

Abstract:

The reaction **3He(n,p)3H** has a great relevance for the primordial nucleosynthesis and its reaction rate impacts the calculated primordial abundances for several isotopes among which the lithium, whose abundance is determining the so-called lithium problem. In fact Lithium puzzle is one the most intriguing unsolved problem at our days. Its predicted abundance by CMB evaluations is generally accepted to be a factor about 3 higher than the one deduced by halo stars. The Trojan Horse Method allows to study neutron induced reaction at astrophysical energies and it will be applied to the **3He(d,pp)3H** for studying the **3He(n,p)3H,** thus using a deuteron to transfer a neutron**.** The aim of the work will be to carry out energy and position calibration of charge-partition position sensitive detectors and the extraction of the two-body reaction cross section of interest. This will be the key ingredient for evaluating the impact of the THM result on the cosmological scenario.

21. STUDY OF PYGMY RESONANCE IN RADIOACTIVE BEAMS EXCITED WITH BOTH ISOSCALAR AND ISOVECTOR PROBES

LNS – CATANIA

Supervisors: Prof. F. Rizzo rizzo@lns.infn.it, Dipartimento di Fisica e Astronomia di Catania and dott. P. Russotto Russotto@lns.infn.it, INFN-LNS

ABSTRACT:

The NEWCHIM group of LNS is involved in the construction and use of the FARCOS correlator (Femtoscopy ARray For Correlation measurements and Spectroscopy). This array will consist in its final configuration of 20 triple telescopes of silicon strip and CsI, 12 of which will be already available in the second semester of 2019. This array will be used with fragmentation beams at LNS performing measurements on the excitation of Pygmy Dipole Resonance (PDR) on ^{68}Ni by isoscalar and isovector probes (Carbon and Gold targets). Gamma rays from PDR will be detected in the CsI(tl) detectors of the CHIMERA array, while ^{68}Ni scattered will be detected and identified around zero degree with some FARCOS telescopes. The student will participate at LNS to this experiment and eventually to other experiments performed in the same experimental campaign. He will then perform part of the data analysis of the experiment in order to complete its master thesis. It will be involved also in the mounting and test of FARCOS telescopes. He can learn how to use the full digital electronics of the array and the use of ASIC preamplifiers developed for FARCOS. The student will also learn modern methods of production of radioactive beams, with the setting of the tagging systems for event by event identification of the fragmentation beam. Techniques for the synchronization of acquisition systems will be also used. If the student is also interested to theoretical aspect of the population and decay of Pygmy Resonances he will be able to collaborate with the theory group of the Catania, Padova and Valencia Universities, also involved in the project.

22. RESEARCH AND DEVELOPMENT OF A NEW MODULAR DEVICE FOR CHARGED PARTICLE AND NEUTRON DETECTIOIN WITH HIGH ANGULAR RESOLUTION

LNS – CATANIA

Supervisors: Prof. G. Politi giuseppe.politi@ct.infn.it, Dipartimento di Fisica e Astronomia di Catania and dott. E.V. Pagano epagano@lns.infn.it, INFN-LNS

ABSTRACT:

The NEWCHIM group of LNS has been working from some years to the development of a new modular device for the simultaneous detection of light charged particles and neutron with high energy and angular resolution. Several test on a new scintillating plastic material have been done in order to study its characteristics in term of pulse shape identification of neutron gamma and charged particles, using a digitalization of the light signal. Several simulations and experimental tests are still to be done in order to define the good light sensor between photodiode and SiPM, and to choose the precise geometry in term of dimensions, number and assembly of the single detection cell of the final array. The student will thus be involved in simulation concerning neutron detection with single and multiple cells in a particular surrounding environment. Moreover he will carry on several tests for the choice of the ideal light sensor to be coupled to the plastic scintillator, and to test its performance in term of light yield, timing response and pulse shape identification capabilities. The use of a dedicated front end electronics coupled to a fully digital electronics for signal acquisition is foreseen, and the student will be engaged in the development and test of all these systems. The work will be carried on between the LNS and the Dipartimento di Fisica e Astronomia, profiting of all the experience of the NEWCHIM in the field of detector and associated electronics development.

23. STUDY OF THE STRANGE RESONANCE K*(892)± PRODUCTION WITH ALICE AT LHC

INFN – Sezione di Catania and Physics Department Catania University

Supervisors: A. Badalà (Angela.Badala@ct.infn.it),
F. Riggi (Franco.Riggi@ct.infn.it)

ABSTRACT

The ultrarelativistic heavy ion collisions are able to recreate in the laboratory the Quark Gluon Plasma (QGP) matter, which should be the same dense and hot matter which filled the universe some micro seconds after the Big Bang. ALICE detector is the experiment at the Large Hadron Collider (LHC) at CERN devoted to study the formation and the characteristics of the QGP. Short-lived resonances, which have a lifetime similar to the one of the fireball created in heavy ion collisions, are a good probe of the hadronic phase of these collisions. Furthermore enhancement of strangeness production is one of the first signature proposed for the existence of the QGP. Recent results have shown as collective phenomena and signature (for example strangeness enhancement) peculiar of QGP formation are also present in high multiplicity proton-proton collisions. The student will analyze a sample of the recent data collected by ALICE in pp collisions at the c.m. energy of 13 TeV, the largest energy reached at LHC, to measure the transverse momentum spectrum and the yield of the strange $K^*(892)^{\pm}$ resonance as a function of the charged multiplicity of the collision.

24. PERFORMANCE OF THE HADRONIC CALORIMETER HCAL-J FOR THE MEASUREMENT OF THE NUCLEON MAGNETIC FORM FACTOR AT JEFFERSON LAB.

Università e Sezione INFN di Catania, Italy

Supervisors: Bogdan Wojtsekhowski (bogdanw@jlab.org) (Jefferson Lab, Newport News, VA, USA), Catia Petta (catia.petta@ct.infn.it) (Sezione INFN and University of Catania, Italy), Concetta Sutera (concetta.sutera@ct.infn.it) (Sezione INFN and University of Catania, Italy)

ABSTRACT:

The experimental study of the Electromagnetic Form Factors of the nucleons is one of the goals of the nuclear research at Jefferson Lab in the next future. GMn is the first experiment in the schedule and it will start data taking in 2020. It will use 4.4 to 11 GeV CEBAF electron beam energies on a liquid deuterium target, in order to measure the neutron magnetic form factor with a total accuracy better than 2-3%. The used technique is based on the detection of the scattered electron and the recoiling nucleon in coincidence in order to measure the ratio of the cross sections for the two quasi-elastic processes. This work aims to focus the performances (threshold, efficiency and spatial resolution) required by the experiment to the HCAL-J hadronic calorimeter, in the Hall A of the Jefferson Lab.