Memorandum of Understanding

between

Istituto Nazionale di Fisica Nucleare (INFN)
Via Enrico Fermi, 40 – 00044 Frascati (Rome), Italy

and

University of Ioannina
Panepistimiou Avenue, GR-45110 Ioannina, Greece

and

University of Athens
Panepisthmiou Avenue 30, GR10679 Athens, Greece

and

Hellenic Insitute of Nuclear Physics
Panepistimiou Avenue, GR-45110 Ioannina, Greece

herein after referred to collectively as "**Parties**" and separately as "**Party**".

1. PREAMBLE

The collaboration in Nuclear Physics between Italian and Greek Institutions has been very active in the last decade. In this context the program for which this MoU is being established constitutes a perfect example of the emergence of new collaboration.
With the present MoU such collaboration will be strengthened within a well-defined research program.

2. PARTIES AND THEIR REPRESENTATION

Hereafter the **Institutes**:

1)
LNS, Catania
Laboratori Nazionali del Sud, INFN
Via S.Sofia 62, I 95125,
Catania, Italy

INFN
Istituto Nazionale di Fisica Nucleare
Via Enrico Fermi , 40 – 00044
Frascati (Rome) Italy

2)
University of Ioannina (UoI)
Panepistimiou Avenue, GR45110 Ioannina,
Greece
and
University of Athens(UoA)
Panepistimiou Avenue 30, GR10679
Athens, Greece
and
Hellenic Institute of Nuclear Physics
(HINP)
Panepistimiou Avenue, GR45110 Ioannina,
Greece

are referred to collectively as "**Parties**" and separately as "**Party**".

3. SCOPE OF APPLICATION

The Italian - Greek collaboration is strongly interested in developing a research program based on experiments with heavy and light ions and tests of detectors which will be performed at the MAGNEX facility of INFN-LNS laboratory. The collaboration offers the know-how for running the MAGNEX spectrometer and for setting up tests of detectors. The focus will be on three main topics

1. Double Charge Exchange (DCE) reactions induced by heavy ions in the view of the extraction of matrix elements useful for the research of neutrino-less double beta decay. In particular, the collaboration supports the NUMEN project of INFN, with special focus on data-taking, data analyses, development of specific nuclear reaction theories and development of detectors. The collaboration offers the extraction of cross sections from the raw data and for the determination of DCE matrix elements from the measured cross sections.
2. Study of elastic-inelastic scattering in inverse kinematics for weakly bound nuclei by protons and deuterons with emphasis on breakup modes for its own right as well as for evaluation of coupling channel effects. This is a campaign from the University of Ioannina. In particular the collaboration supports this campaign with special focus on the performance of the experiments and the data analysis.
3. Study of multinucleon transfer reactions in the energy range of 10-20 MeV/u with beams of ^{48}Ca, ^{70}Zn, ^{86}Kr (and eventually projectile-fission of ^{238}U) on heavy n-rich targets (^{64}Ni, ^{124}Sn, ^{238}U). This is a campaign from the University of Athens. The goal is to measure the production cross sections (and the angular distributions) of extremely neutron-rich nuclides toward the r-process path and the n-drip line. This project will extend the effective application of the MAGNEX spectrometer to heavy beams of high intensity from the S800 Cyclotron. In

particular the collaboration will support this campaign with special focus on the performance of the experiments and the data analysis.

4. SUBJECT MATTER OF THE MEMORANDUM OF UNDERSTANDING

The present MoU defines the organization under which the collaboration between INFN-LNS and UoI, UoA and HINP operates. It also sets a number of conventions and responsibilities of each Party to follow. Further, it allows the Parties to foster collaborations outside the Parties in question.

5. SITE CONDITIONS AND SAFETY PROCEDURES

All the research activities shall be carried out in compliance with the LNS guidelines attached to this document as Annex 1 (General Conditions applicable to Experiments performed at INFN National Laboratories).

Each Party shall require its researchers, employees, agents and guests participating in the experiments to comply with all Safety procedures as detailed by the hosting Laboratory and required by applicable law. All the operations performed on the experimental site and in the external facilities of LNS will be carried out in full compliance with the LNS safety rules.

Each member of the collaboration will be fully responsible of her/his actions in face of LNS regulations and of Italian law.

The Director of LNS will appoint a Group Leader In Matter Of Safety (GLIMOS) on the proposal of the Spokesperson. The rights and responsibilities of the GLIMOS are defined in the safety documents issued by LNS.

The use of the MAGNEX spectrometer will be under the responsibility of the LNS - Research Division. The set-up of the device, including detectors, electronics and data acquisition for the experiments will be managed by the NUMEN collaboration.

6. COORDINATION

As coordinators for this Memorandum of Understanding the following are appointed: on behalf of Insituto Nazionale di Fisica Nucleare, Prof. Francesco Cappuzzello, on behalf of the University of Ioannina, University of Athens and Hellenic Insitute of Nuclear Physics, Prof. Athena Pakou. Upon the impediment of

any of the coordinators, for whatever reason, a new coordinator will be indicated by the Director of the respective Party

7. MEMBERS OF THE COLLABORATION

The collaboration involves researchers from the INFN-LNS and UoI and UoA and HINP institutions. A detailed list of the member of the collaboration describing the role and possible responsibilities of each one will be defined in future correspondences between the coordinators of the MOU.

Within the present collaboration, a Scientific Coordination Group (SCG) is defined with members of the collaboration from INFN-LNS UoI, UoA and HINP. The SCG will manage the scientific activity proposed within the collaboration, under the framework of the NUMEN project. The Collaboration appoints a member of the collaboration as Spokesperson. He/She will represent the Collaboration to the outside and coordinates its work.

8. SIGNATURE AND DURATION

The MoU comes into force upon signature by the head of each of the Parties and remains in force till June 30st 2019. Its duration can be prolonged upon written agreement of the Parties, but cannot exceed 36 months. It can be revised at the request of one of the Parties.

9. FINANCIAL ASPECTS

The resources for developing the project in terms of equipment, provision, consumables and whatsoever will be requested according to procedures established for the INFN NUMEN project.

In any case this MoU foresees direct financial burdens from INFN-LNS that do not exceed 50 k€ for its entire duration.

The NUMEN project requires that long term data-taking runs (typically 8-10 weeks for each experiment) will be performed at the INFN-LNS laboratory. This requires that the major part of the experimental activity will be done in Catania. The Greek Party (UoI, UoA and HINP) will contribute offering expertise and manpower for the data-taking runs and for data reduction and data analysis of the NUMEN project that will be partly performed at the Greek Institutions.

10. EXPERIMENTAL PROPOSALS

The collaboration will propose experiments and tests of detectors to the LNS following the standard procedure.

Dr. Giacomo Cuttone
Director of INFN-LNS

26 APR. 2017

Prof. G. Kapsalis
Rector of UoI

Prof. Th. Sfikopoulos
Vice Rector of UoA

Prof. Th. Sfikopoulos
Vice Rector of Research and Development

Prof. G. Lalazissis
President of HINP