



Laurea Magistrale in Fisica – Curriculum NuPhys

Erasmus Mundus Joint Master Degree on Nuclear Physics

DEADLINE FOR APPLICATION: MARCH 10, 2017

Presentation

NuPhys is a 2-years Erasmus+: Erasmus Mundus Joint Master Degree programme in Nuclear Physics (120 ECTS). The programme will start in 2017-2018 as an [Erasmus Mundus](#) / [Erasmus+](#) Master Course of the European Union. The Master Course is offered by a consortium of **8 partner universities** in Spain, France and Italy, with the participation of 16 research institutions/companies as associated partners in Spain, France, Italy, Germany and Switzerland (CERN).

Nuclear Physics is a broad matter of relevance from both the fundamental knowledge of Nature and the multiple applications to different fields of strategic economical relevance. These include energy resources (based on fusion or fission), biomedical sciences, analysis and characterization of new materials, environmental studies (atmosphere, soil, waters), dating, art and archaeometry, airport and toll security, military applications, industrial automatization and control, fire surveillance, among others. The main objective of the programme is to provide top-ranked students with an excellent background in Nuclear Physics so as to educate experts in the field to meet the needs and challenges previously mentioned, and foster their future career in this field. At the same time, NuPhys students carry out their master studies in least 3 countries, in a stimulating and scientifically excellent international environment.

NuPhys has a double educational approach. First, to train well-prepared specialists to enter the industry in any of the fields mentioned above. Second, to train students able to develop research programmes and make their PhD in the field of Nuclear Physics.

The official language of the course is English, but students are given the possibility to learn the languages of the host countries by attending language courses at the partner universities.

Successful students will be awarded a Joint Master Degree by all partner universities.

In addition they will obtain a Diploma Supplement to facilitate the recognition of their degree in other universities/countries.

Structure and main topics

The Master is structured in five modules and divided into four semesters. A common introductory week and a common basis of fundamental knowledge will be given during the first semester. A progressive specialization is then acquired through one of three different paths offered: 1) Experiments in large accelerators, 2) Theoretical nuclear physics, and 3) Applications and small accelerators. All students will spend at least one semester in each participant country, and will benefit of a fully adapted curriculum according to their specialization path. Visits to nuclear physics facilities, distinguished visiting scholars, a 2-months internship, a common summer course (in collaboration with the TALENT USA-EU initiative), and the Master Thesis, complete the study programme.

NuPhys offers an excellent educational level in all branches of Nuclear Physics, including theoretical, experimental and applications. The main topics covered by the Master programme are:

- ☐ Nuclear Structure
- ☐ Nuclear Reactions
- ☐ Experimental Nuclear Physics
- ☐ Nuclear Astrophysics
- ☐ Nuclear Physics Applications for Therapy
- ☐ Nuclear Physics Applications in Small Accelerators
- ☐ Nuclear Physics Applications to Archaeometry
- ☐ Nuclear Instrumentation
- ☐ Experiments in Large Accelerators

Study Programme

This Curriculum is based on the expertise of a consortium of Spanish Universities (Seville, Autónoma de Madrid, Barcelona, Complutense de Madrid and Salamanca) plus Universities of Caen Basse-Normandie, Padova, and **Catania**.

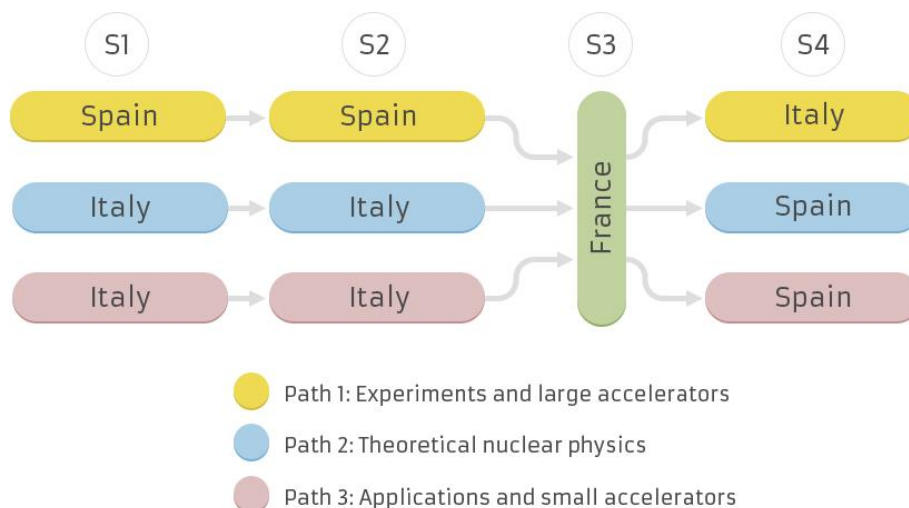
The programme further benefits from the participation of the associated partners: CERN: European Organization for Nuclear Research (Geneva, Switzerland), CNA: Centro Nacional de Aceleradores (Seville, Spain), CMAM: Centro de Microanálisis de Materiales (Madrid, Spain), CIEMAT: Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas (Madrid, Spain), CSIC: Consejo Superior de Investigaciones Científicas (Spain), INFN - Laboratori Nazionali di Legnaro (Legnaro, Italy), HGS-HiRe: Helmholtz Graduate School for Hadron and Ion Research for FAIR (Darmstadt, Germany), GANIL: Grand Accélérateur National d'Ions Lourds (Caen, France), **INFN-CT and LNS: Istituto Nazionale di Fisica Nucleare (Catania, Italy)** (includes AOUP: Azienda Ospedaliero-Universitaria Policlinico di Catania), CNRS-In2p3-LPC: Centre National pour la Recherche Scientifique- Institut National pour la Physique Nucléaire et des Particules- Laboratoire de Physique Corpusculaire (Caen, France), ENSICAEN: Ecole Nationale Supérieure, (Caen, France), TALENT: Training in Advanced Low Energy Nuclear Theory (EU-USA), HVM: Hospital Virgen Macarena (Sevilla, Spain), CETIR: Image Diagnostic Company (Barcelona, Spain), AAA: Advanced Accelerator Applications (Ibérica) S.L (Barcelona, Spain), NUCLEOPOLIS: Pôle Nucléaire Normand pour la Santé et l'Énergie (Caen, France), ARCADE: Advanced Resource Center for HADrontherapy in Europe (Caen, France).

Organization of NuPhys

The Curriculum is divided in four semesters (S) organized in three specialization paths:

- PATH 1: Experiments and Instrumentation in large accelerators. Students following this path (50% approx) will start in Spain for S1 & S2, then go to France for S3 and finally will go to Italy (either Padova or Catania) for the Master Thesis in S4.
- PATH 2: Theoretical nuclear physics. Students within this path (25% approx) will start in Italy (Padova) for S1 & S2, then to France for S3 and, finally to Spain for the Master Thesis in S4.
- PATH 3: Nuclear Phenomena and their applications : Applied Nuclear Physics and small accelerators. Students within this path (25% approx) will start in Italy (Catania) for S1 & S2, then to France for S3 and, finally to Spain for the Master Thesis in S4.

The first semester is focused on basic learning in Nuclear Physics and tools, while the subsequent ones offer to the students the possibility to specialise in different branches. The organization in semesters is summarised in the table below.



The detailed lists of courses offered at the various universities in the relevant semesters are available in the section Curricula of web page

<http://alojamientosv.us.es/nuphysimd/>



The Curriculum is structured for all students in 5 modules and divided into 4 terms (semesters).

Module 1 Basic Nuclear Physics and Tools	Module 2 Advanced Nuclear Physics (Exp.)	Module 2 Advanced Nuclear Physics (Theo.)	Module 2 Advanced Nuclear Physics (App.)	Module 3 Common Advanced Course	Module 4 Internship	Module 5 Master Thesis
---	---	--	---	--	------------------------	------------------------------

For students following Path (accelerators and applied nuclear physics – S1 and S2 in Catania) the courses are shown in the following table. The corresponding ECTs (in brackets), the SSD and “Tipologia” caratterizzante C or Affine A are reported for each course.

Catania S1	Advanced Quantum Mechanics - (FIS/02) - C	Advanced Mechanical Statistics -(FIS/02)- C	Nuclear Physics Laboratory (FIS/01)- C	Nuclear and Subnuclear Physics / Nuclear Structure - (FIS/04) - C	Advanced Nuclear Techniques applied to Medicine- (FIS/07) / Environmental Radioactivity (FIS/01)– A
Catania S2	Theory of Nuclear Reaction -(FIS/02) - A	Theory of Strong Interactions (FIS/02) - A	Nuclear Astrophysics - (FIS/04-05) - C	Experimental methods for nuclear physics - (FIS/01)/ Laboratory of Environment al Physics - (FIS/07) C	Archeometry/ Accelerators Physics and applications (FIS/07)- A
France S3	Research Internship/Thesis (12)	Common Advanced course (12)	Data Analysis -(FIS/01)/ Accelerators - FIS/01 o 07)/ Applications for therapy - FIS/07		
Spain S4	Master Thesis on Nuclear phenomena and their applications (30)*				

* The Master Thesis for this Path will be performed in Spain (30 ECTS), however the Research Internship in France will be dedicated to develop the project for the Thesis and will bring the further 12 ECTS required for the Laurea Magistrale in Italy.

** All courses are 6 ECTS except where indicates differently in S3 and S4