ERASMUS MUNDUS MASTER IN NUCLEAR PHYSICS
Academic Year 2024/2025

MASTER THESIS PROPOSAL

TITLE: Systematic optical potentials for reactions with cluster-structured nuclei

SUPERVISORS: Marcos Aurelio Gonzalez Alvarez and Juan Pablo Fernández García

SUPERVISOR contact-email: malvarez@us.es Telephone: 954552889
SUPERVISOR contact-email: jpfernandez@us.es Telephone: 954552889

UNIVERSITY/RESEARCH CENTER: University of Seville

ABSTRACT

This proposal relies on a specific research line of the Department of Atomic, Molecular and Nuclear Physics (FAMN), of the University of Seville (US): *the development of instrumentation, for nuclear reactions measurements and their applications in Astrophysics*. The proposal has the objective of training students to research in the area of Physics dedicated to nuclear reactions. For this, we address the three main fronts of knowledge in Physics: instrumental, experimental and theoretical. Particularly, we propose systematic analyzes of experimental data on nuclear reactions, applying different theoretical optical models (OM) for the nuclear potential. We apply optical potentials (OP) to the study reactions of stable (tightly and weakly bound) and exotic nuclei. We propose determine systematic OP to describe the collisions of isotopes nuclei of ^{4,6}He (Z=2); ^{6,7,8,9,11}Li (Z=3); ^{9,10,11}Be (Z=4); ^{8,10,11}B (Z=5); ^{12,13}C (Z=6) and ^{16,18}O (Z=8).

In the scenario of Astrophysics, regarding to the abundance of elements in the cosmos, as a function of the atomic number (Z), the isotopes of Li (Z=3), Be (Z=4) and B (Z= 5) are characterized by lower binding energies and are found in a valley of abundance, among its most abundant neighbors, the isotopes of He (Z=2) and C (Z=6). Thus, we study and compare the reactions rates of these isotopes (as projectiles) in collisions against nuclei targets in different regions of mass (A) in the periodic table. Such analyzes are performed at energies around the respective Coulomb barrier, for each system in collision. In Physical Review C 109, 054608 (2024) - (DOI: 10.1103/PhysRevC.109.054608) and Physical Review C 100, 064602 (2019) - (DOI: 10.1103/PhysRevC.100.064602) systematical OP studies of light nuclei reactions respectively on ^{64}Zn and ^{120}Sn targets have been published. This work is part of scientific collaborations associated to international nuclear Astrophysics networks: IANNA (*Ibero American Network for Nuclear Astrophysics*) and IReNA (*International Research Network for Nuclear Astrophysics* – https://www.irenaweb.org/).

ERASMUS MUNDUS MASTER IN NUCLEAR PHYSICS
Academic Year 2024/2025

MASTER THESIS PROPOSAL

TITLE: Exploring the weakly bound nucleus ^{10}Be.

SUPERVISOR(S): Juan Pablo Fernández García

SUPERVISOR(S) contact- email: jpfernandez@us.es Telephone: 954551889
email: Telephone:

UNIVERSITY/RESEARCH CENTER: University of Seville

ABSTRACT
(just few lines 5-10 explaining briefly the idea of the proposed work and the place where it will be developed).

During the proposed master thesis, the experimental data of the ^{10}Be+^{120}Sn reaction at energies around and above the Coulomb barrier measured at the Laboratori Nazionali del Sud (Catania, Italy) will be analyzed. Starting from the characterization of the experimental setup and finishing with the analysis of different reactions channels; elastic scattering, inelastic scattering and breakup. The results will be essential to understand the structure and reaction mechanisms of weakly bound nuclei ^{10}Be and to shed light on the behavior of nuclear forces in few-body interacting systems.

ERASMUS MUNDUS MASTER IN NUCLEAR PHYSICS
Academic Year 2024/2025

MASTER THESIS PROPOSAL

TITLE: "Long-lived radionuclides detection by Accelerator Mass Spectrometry"

SUPERVISOR(S): José María López Gutiérrez

SUPERVISOR(S) contact- email: LGUTI@US.ES Telephone: 654618648
email: Telephone:

UNIVERSITY/RESEARCH CENTER: Universidad de Sevilla/Centro Nacional de Aceleradores

ABSTRACT
(just few lines 5-10 explaining briefly the idea of the proposed work and the place where it will be developed).

Accelerator Mass Spectrometry (AMS) is an ultrasensitive technique for the detection of long-lived radionuclides in natural or artificial environments. The use of a particle accelerator strongly enhances the ability of mass spectrometry to detect radionuclides. This makes of AMS a technique that can be applied to problems in many scientific fields. The technique is available at the Centro Nacional de Aceleradores (CNA). The student will develop his/her Master Thesis applying the technique to samples of interest for the projects that are currently being carried out by the AMS group. The student will learn how to prepare these samples and will learn notions on the use of particle accelerators for AMS.

ERASMUS MUNDUS MASTER IN NUCLEAR PHYSICS
Academic Year 2024/2025

MASTER THESIS PROPOSAL

TITLE: Extension of the Microdosimetric Gamma Model to X-Rays and Electrons for Characterizing DNA Damage in Radiation Therapy

SUPERVISOR(S): Miguel Cortés-Giraldo (Universidad de Sevilla)
Alejandro Bertolet (Massachusetts General Hospital and Harvard Medical School)

SUPERVISOR(S) contact- email: miancortes@us.es Telephone:
email: abertoletreina@mgh.harvard.edu Telephone:

UNIVERSITY/RESEARCH CENTER:
Universidad de Sevilla (Spain)
Massachusetts General Hospital and Harvard Medical School (USA)

ABSTRACT
(just few lines 5-10 explaining briefly the idea of the proposed work and the place where it will be developed).

This work will focus on expanding the Microdosimetric Gamma Model (MGM), which currently calculates DNA damage from protons and alpha particles, to include additional radiation modalities such as x-rays and electrons. These radiation types are widely used in clinical therapy, but their microdosimetric characterization and impact on DNA damage require further study. The project will involve incorporating these particles into the MGM framework, improving its capability to predict radiation-induced biological effects across different therapeutic modalities. The project will be carried out at the Universidad de Sevilla, with co-supervision from MGH/Harvard Medical School.

*All Master Thesis' projects with A. Bertolet are entitled for only one single vacancy.

ERASMUS MUNDUS MASTER IN NUCLEAR PHYSICS
Academic Year 2024/2025

MASTER THESIS PROPOSAL

TITLE: Development of an Anatomical Model of Salivary Glands for Microdosimetry in Alpha-Particle Targeted Therapy

SUPERVISOR(S): Miguel Cortés-Giraldo (Universidad de Sevilla)
Alejandro Bertolet (Massachusetts General Hospital and Harvard Medical School)

SUPERVISOR(S) contact- email: miancortes@us.es Telephone:
email: abertoletreina@mgh.harvard.edu Telephone:

UNIVERSITY/RESEARCH CENTER:
Universidad de Sevilla (Spain)
Massachusetts General Hospital and Harvard Medical School (USA)

ABSTRACT
(just few lines 5-10 explaining briefly the idea of the proposed work and the place where it will be developed).

This work will focus on the development of an anatomical model of the salivary glands to study microdosimetry in alpha-particle targeted therapy. Alpha-emitting radiopharmaceuticals are increasingly used in cancer treatment, particularly in prostate cancer through PSMA (Prostate-Specific Membrane Antigen) targeting. However, toxicities in non-target organs, such as the salivary glands, remain a concern. This project aims to model the microdistribution of alpha-emitters in salivary tissues to better understand and mitigate side effects in future therapies. The work will be conducted at the Universidad de Sevilla, with co-supervision from MGH/Harvard Medical School.

*All Master Thesis' projects with A. Bertolet are entitled for only one single vacancy.

ERASMUS MUNDUS MASTER IN NUCLEAR PHYSICS
Academic Year 2024/2025

MASTER THESIS PROPOSAL

TITLE: Error field mitigation in the SMall Aspect Ratio Tokamak

SUPERVISOR(S): Diego Jose Cruz Zabala
Manuel Garcia Munoz

SUPERVISOR(S) contact- email: dcruz3@us.es Telephone: +34 691253288
email: mgm@us.es Telephone: +34 651977475

UNIVERSITY/RESEARCH CENTER: Universidad de Sevilla

ABSTRACT
(just few lines 5-10 explaining briefly the idea of the proposed work and the place where it will be developed).

In tokamaks, the biggest component to the magnetic field is generated by toroidal field coils. The number of toroidal field coils is normally limited to leave space for accessing the machine. For this reason, gaps in between the toroidal field coils generate variations in the toroidal magnetic field that could induce particle losses. Furthermore, due to tolerances in the manufacturing of the coils, variations in the magnetic field induced by these coils can appear. Error fields account for these variations in the toroidal magnetic field. In this work, error fields in the SMART tokamak will be modeled. Furthermore, compensation coils will be designed in order to minimize the error fields.

ERASMUS MUNDUS MASTER IN NUCLEAR PHYSICS
Academic Year 2024/2025

MASTER THESIS PROPOSAL

TITLE: Detector developments towards real-time dose monitoring via Compton imaging in radiotherapy

SUPERVISOR(S): Pablo Torres Sánchez, Jorge Lerendegui Marco, Carlos Guerrero Sánchez

SUPERVISOR(S) contact email: pablo.torres@ific.uv.es Telephone: +34 963543521
email: jorge.lerendegui@ific.uv.es Telephone: +34 963543727
email: cguerrero4@us.es Telephone: +34 954460553

UNIVERSITY/RESEARCH CENTER:
Universidad de Sevilla (US) / Instituto de Física Corpuscular (CSIC-UV)

ABSTRACT
(just few lines 5-10 explaining briefly the idea of the proposed work and the place where it will be developed).

Detector development is gaining interest in medical physics, aiming to enhance current technologies and introduce new imaging and treatment techniques, particularly where commercial products are unavailable. This is the case for ion-range verification in hadron therapy (HT) and real-time dosimetry in boron neutron capture therapy (BNCT). In HT, secondary neutrons are produced when the beam interacts with patient tissues, while in BNCT, neutrons are the primary component of the beam. Therefore, detectors with low neutron sensitivity and high-count rate capabilities are ideal for dosimetry in these treatments.

The i-TED Compton Camera Array, developed at IFIC for nuclear physics research, is being adapted for medical use profiting from its low neutron sensitivity, larger efficiency and other technical aspects. Key challenges include handling high counting rates, where segmented crystals offer an advantage, and imaging large volumes, which requires 3D reconstruction and tomographic techniques. Using a gantry to rotate the detector around the imaging area is particularly useful for these tasks.

This Master thesis at IFIC will explore these challenges, incorporating experimental lab work, data analysis, and Monte Carlo simulations.

ERASMUS MUNDUS MASTER IN NUCLEAR PHYSICS
Academic Year 2024/2025

MASTER THESIS PROPOSAL

TITLE: Development of a multi-delay Coherence Imaging Spectroscopy diagnostic for Wendelstein 7-X

SUPERVISOR(S): Eleonora Viezzer

SUPERVISOR(S) contact- email: eviezzer@us.es Telephone:
email: Telephone:

UNIVERSITY/RESEARCH CENTER: Universidad de Sevilla

ABSTRACT
(just few lines 5-10 explaining briefly the idea of the proposed work and the place where it will be developed).

Coherence Imaging Spectroscopy is a novel diagnostic technique used in nuclear fusion experiments, consisting of encoding the spectral line shape of the light emitted by the plasma in a 2D fringe pattern. 2D maps of some relevant plasma parameters such as ion temperature can be obtained. While powerful, this technique lacks the ability to differentiate between different sources of radiation, complicating the analysis of the data.
In this master thesis, the development of and further improvement of an already exisiting CIS diagnostic present at the Wendelstein 7-X stellarator will be studied.
Using a synthetic diagnostic, the feasibility of new measuring techniques will be assessed, and the system components optimized for such purposes.

[1] R Lopez-Cansino et al 2024 Plasma Phys. Control. Fusion 66 045012
[2] R Lopez-Cansino et al 2024 Rev. Sci. Instrum. 95 083524