



ERASMUS MUNDUS JOINT MASTER IN NUCLEAR PHYSICS

Academic Year 2026/2027

MASTER THESIS PROPOSAL

TITLE: Performance Evaluation and Temporal Resolution Benchmarking of Next-Generation ASIC Readout Electronics for Compton Imaging

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UNIVERSITY/RESEARCH CENTER: 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).

GNVision is an AI-assisted, dual gamma-neutron radiation detector that leverages advanced computerized imaging techniques for cutting-edge applications, including radioactive waste characterization, range verification in proton therapy via PET-Compton imaging, and dose validation in experimental neutron therapies such as BNCT.

This Master's thesis project focuses on evaluating a novel ASIC readout electronics system developed by PulSensing to enhance GNVision's imaging performance. The work involves conducting systematic experimental measurements to benchmark its temporal resolution against current industry-standard electronics (PETSys). The research will be carried out at the Instituto de Física Corpuscular (IFIC) in Valencia, providing a supportive, high-level laboratory environment where the student will receive continuous guidance while gaining hands-on experience in detector characterization and comparative analysis.

**ERASMUS MUNDUS JOINT MASTER IN NUCLEAR PHYSICS**

Academic Year 2026/2027

MASTER THESIS PROPOSAL

TITLE: Mapping the Nuclear Reactions Dynamics: Optical Potentials, Relation Dispersion and Threshold Anomalies

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UNIVERSITY/RESEARCH CENTER: Department of Atomic, Molecular and Nuclear Physics

ABSTRACT

The main objective of this project is to introduce the student to nuclear reaction data analysis through systematic optical model (OM) studies of reactions involving different projectiles and heavy target nuclei [1–4].

The analysis will be based on the second version of the São Paulo potential (SPP2) [5], with particular emphasis on determining the real and imaginary components of the optical potential (OP), their uncertainties, and their correlations.

The project will investigate the energy dependence of the OP and the dispersion relation (DR), with special attention to the threshold anomaly (TA) and breakup threshold anomaly (BTA) in reactions involving tightly and weakly bound nuclei, respectively. The sensitivity of data to the OP will also be studied, together with its correlation with projectile binding energy and breakup properties. A further objective is to identify collision-energy regions where projectile dissociation is enhanced, considering the breakup Q-value and Coulomb barrier of the reaction system.

The results will provide insight into the role of nuclear structure in reaction dynamics and help guide the planning of future experiments. The extracted optical potentials will also provide input for subsequent microscopic coupled-channel (CC) calculations.

1) Physical Review C **100**, 064602 (2019)

DOI: <https://doi.org/10.1103/PhysRevC.100.064602>

2) Physical Review C **109**, 054608 (2024)

DOI: <https://doi.org/10.1103/PhysRevC.109.054608>

3) Physical Review C **111**, 034615 (2025)

DOI: <https://doi.org/10.1103/PhysRevC.111.034615>

4) Physical Review C **113**, 044607 (2026)

DOI: <https://doi.org/10.1103/7zjd-q8qd>

5) Computer Physics Communications

Volume 267, 2021, 108061

DOI: <https://doi.org/10.1016/j.cpc.2021.108061>



ERASMUS MUNDUS JOINT MASTER IN NUCLEAR PHYSICS

Academic Year 2026/2027

MASTER THESIS PROPOSAL

TITLE: Soil moisture from cosmic-ray neutrons: exploring Cosmic-Ray Neutron Sensing with the HENSA++ spectrometer

SUPERVISOR(S): Ariel Tarifeño-Saldivia, Álvaro Quero Ballesteros

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UNIVERSITY/RESEARCH CENTER: Instituto de Física Corpuscular (IFIC), CSIC – Universitat de València, Valencia (Spain)

ABSTRACT

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

Soil moisture, the water stored in the upper soil layers, is an Essential Climate Variable that controls crop yields, droughts and floods, yet it is hard to measure at the field scale. Cosmic-ray neutrons offer an elegant solution: since hydrogen efficiently slows them down, the neutron flux above the ground reveals the soil water content over several hectares (Cosmic-Ray Neutron Sensing, CRNS). HENSA++ (<https://www.hensaproject.org/>), a neutron spectrometer that has been monitoring the cosmic-ray neutron spectrum from thermal to GeV energies at the Javalambre Astrophysical Observatory (Teruel, Spain) since October 2024 for space-weather and dosimetry studies, has not yet been explored for this purpose. Using Geant4 Monte Carlo simulations and physical-mathematical models, the student will assess the feasibility of HENSA++ for soil-moisture measurements and develop retrieval methods, tested on HENSA++ and local weather data. Host institution: IFIC (CSIC – UV), Valencia.



ERASMUS MUNDUS JOINT MASTER IN NUCLEAR PHYSICS

Academic Year 2026/2027

MASTER THESIS PROPOSAL

TITLE: Development of a cryogenic Penning trap for single-proton production and detection

SUPERVISOR(S): Juan Pablo Fernández García, Juan Manuel Cornejo García

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UNIVERSITY/RESEARCH CENTER: Universidad de Sevilla / Universidad de Cádiz

ABSTRACT

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

This Master's thesis will focus on the development of a cryogenic Penning-trap setup for the production and detection of single protons, with potential applications within the BASE (Baryon Antibaryon Symmetry Experiment) collaboration. This international collaboration aims to perform stringent tests of fundamental CPT symmetry through ultra-high-precision comparisons of the intrinsic properties of protons and antiprotons. The experimental setup will include a two-stage cryocooler capable of reaching 4 K, a cylindrical Penning trap built with permanent magnets, and a detection system based on image currents induced in the trap electrodes. The student will support the development of this experimental infrastructure through simulations and engineering design using tools such as Autodesk Inventor, Mathematica and SIMION, as well as through the development of experimental control routines using ARTIQ, a Python-based framework. Participation in hands-on experimental activities involving electronics, ultra-high-vacuum systems and cryogenics is highly encouraged, but it is not mandatory. The experimental activities would take place at the Departamento de Física de la Materia Condensada of the Universidad de Cádiz, located in Puerto Real (Cádiz), Spain.

