JOINT EUROPEAN MASTER IN NUCLEAR PHYSICS

Academic Year 2025/2026

MASTER THESIS PROPOSAL

TITLE: **Monte Carlo simulations with Geant4 for gamma spectroscopy and neutron detection based on organic scintillators**

SUPERVISOR(S): Erica Fanchini

SUPERVISOR(S) contact- email: e.fanchini@caen.it

COMPANY: CAEN s.p.a. (Italy)

ABSTRACT

The intern will spend a six-month period at the CAEN s.p.a. company. During this time, they will develop Monte Carlo simulations to study the behavior of scintillators sensitive to gamma and/or neutron radiation for potential industrial applications. The primary objective of the internship is the physical characterization of the sensors. A special focus will be dedicated to the gamma spectroscopy capabilities of the scintillators. The analysis of detection efficiencies in specific configurations and their comparison with experimental measurements will be carried out in the final phase of the project.

JOINT EUROPEAN MASTER IN NUCLEAR PHYSICS

Academic Year 2025/2026

MASTER THESIS PROPOSAL

TITLE: **Analysis and Comparison of Gamma-Emitter Source Identification Algorithms Based on Scintillator Signals for Nuclide Recognition from Gamma Spectra**

SUPERVISOR(S): Erica Fanchini

SUPERVISOR(S) contact- email: e.fanchini@caen.it

COMPANY: CAEN s.p.a. (Italy)

ABSTRACT

The intern will spend a six-month period at the CAEN s.p.a. company. This thesis focuses on the analysis and comparison of algorithms designed to identify gamma-emitting nuclides based on signals from scintillation detectors. Traditional spectral analysis methods will be evaluated alongside more advanced approaches, including neural networks, with the aim of improving detection accuracy, robustness, and computational efficiency. A dedicated code will be developed to benchmark and compare the performance of the different algorithms under varying experimental conditions.

JOINT EUROPEAN MASTER IN NUCLEAR PHYSICS
Academic Year 2025/2026

MASTER THESIS PROPOSAL

TITLE: **Analysis of scintillator signal behavior as a function of temperature and development of an online compensation algorithm**

SUPERVISOR(S): Erica Fanchini

SUPERVISOR(S) contact- email: e.fanchini@caen.it

COMPANY: CAEN s.p.a. (Italy)

ABSTRACT

The intern will spend either a three- or six-month period at the at the CAEN s.p.a. company. During this time, the student will carry out measurements to study the behavior of scintillator signals as a function of temperature. They will evaluate the response and define the approach needed to ensure reliable use of the detectors in various nuclear applications. If the internship extends to six months, the work will include the development of an algorithm for the online correction of energy spectra. Measurements in a climate chamber to investigate temperature effects, as well as tests with radiation sources, are planned.

JOINT EUROPEAN MASTER IN NUCLEAR PHYSICS

Academic Year 2025/2026

MASTER THESIS PROPOSAL

TITLE: **MonteCarlo MCNP Simulations for Low- and Intermediate-Level Nuclear Waste Measurements and Validation with Mock-Up Drums Using Gamma**

EmittersSUPERVISOR(S): Erica Fanchini

SUPERVISOR(S) contact- email: e.fanchini@caen.it

COMPANY: CAEN s.p.a. (Italy)

ABSTRACT

The intern will spend a six-month period at the CAEN s.p.a. company. This thesis focuses on the The intern will spend a six-month period at the CAEN s.p.a. company. The safe characterization and management of low-level waste (LLW) and intermediate-level waste (ILW) are essential steps in the nuclear waste disposal chain. This thesis focuses on the use of Monte Carlo simulations with the MCNP code to model the measurement process of nuclear waste drums. Simulations will be validated through experimental tests using mock-up drums designed to reproduce realistic waste conditions. Measurements with gamma-emitting sources will be performed to benchmark the simulated response and to assess detection efficiency, spectral characteristics, and activity quantification. The integration of computational modeling with experimental validation aims to improve the reliability of nuclear waste assay methods, supporting both regulatory compliance and the optimization of waste management practices.

JOINT EUROPEAN MASTER IN NUCLEAR PHYSICS

Academic Year 2025/2026

MASTER THESIS PROPOSAL

TITLE: Development of Goubau-line setup to measure diagnostic components impedances

SUPERVISOR(S): Dr. Dirk Lipka

SUPERVISOR(S) contact- email: dirk.lipka@desy.de Telephone: +49 40 8998 5480
email: sergey.strokov@desy.de Telephone: +49 40 8998 4209

UNIVERSITY/RESEARCH CENTER: Deutsches Elektronen-Synchrotron

ABSTRACT

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

Vacuum components in particle accelerators can absorb significant power from the beam due to geometric or material discontinuities, potentially leading to dangerously high temperatures. A Goubau-line offers a promising diagnostic technique to measure the impedance of such components before their installation in the vacuum system. Implementing this approach can provide crucial insights and enable substantial improvements in the design and safety of accelerator vacuum components.

The proposed Master's thesis will focus on the development and realization of a Goubau-line test setup and the execution of initial impedance measurements at DESY. The outcomes are expected to directly contribute to optimizing the design of vacuum components and enhancing the operational reliability of accelerator systems.

JOINT EUROPEAN MASTER IN NUCLEAR PHYSICS

Academic Year 2025/2026

MASTER THESIS PROPOSAL

TITLE: Investigation of absolute charge measurement with Toroids

SUPERVISOR(S): Dr. Dirk Lipka

SUPERVISOR(S) contact- email: dirk.lipka@desy.de Telephone: +49 40 8998 5480
email: Telephone:

UNIVERSITY/RESEARCH CENTER: Deutsches Elektronen-Synchrotron

ABSTRACT

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

Precise bunch-charge measurement is a key diagnostic task in particle accelerators. Core-based toroids determine the charge from the voltage induced in a winding, but comparative studies at DESY show values several percent higher than other devices.

To clarify this discrepancy, the thesis will combine detailed RF simulations with targeted measurements. Besides modelling, it will include S-parameter/network analysis to characterize the toroid's transmission behavior and transfer-impedance measurements to quantify its sensitivity, followed by a systematic comparison with beam-based data. This approach aims to improve both the understanding and the accuracy of bunch-charge diagnostics.

JOINT EUROPEAN MASTER IN NUCLEAR PHYSICS
Academic Year 2025/2026

MASTER THESIS PROPOSAL

TITLE: **Searches for new physics with radioactive molecules**

SUPERVISOR(S):
Stephan Malbrunot-Ettenauer
Kia Boon Ng

SUPERVISOR(S) contact- email: sette@triumf.ca Telephone:+1 604.222.1047 ext. 6032
email: kbng@triumf.ca Telephone:

UNIVERSITY/RESEARCH CENTER:

TRIUMF - Canada's particle accelerator centre, Vancouver, British Columbia, Canada.

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

Why does matter dominate over antimatter in the universe? This fundamental question remains unanswered, as current models cannot fully explain the observed asymmetry. Precision measurements of symmetry-violating effects—such as the nuclear Schiff moment in Th-227 within ThF^+ ions—offer a pathway to new physics beyond the Standard Model.

This project focuses on developing an efficient source of ThF^+ ions containing short-lived Th-227, followed by cooling and characterizing their internal quantum states. The work will be carried out at TRIUMF, where Th-227 is produced using the onsite accelerator, supporting future high-precision tests of fundamental symmetries.

JOINT EUROPEAN MASTER IN NUCLEAR PHYSICS

Academic Year 2025/2026

MASTER THESIS PROPOSAL

TITLE: Effects of dissipation on the quasiealastic barrier distributions of the ^{20}Ne+^{90,94,95}Mo systems

SUPERVISOR(S): Giulia Colucci, Agnieszka Trzcińska

SUPERVISOR(S) contact- email: g.colucci@uw.edu.pl Telephone: 22 55 46215
email: aj.trzcinska@uw.edu.pl Telephone: 22 55 46206

UNIVERSITY/RESEARCH CENTER: Heavy Ion Laboratory, University of Warsaw, Poland

ABSTRACT

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

We propose the analysis of data from an experiment carried out at the Heavy Ion Laboratory (HIL) of the University of Warsaw with the CUDAC3 setup, aimed at investigating the fusion barrier distributions for the systems ^{20}Ne + ^{92,94,95}Mo. The CUDAC3 scattering chamber used in this measurement is equipped with an array of 30 silicon PIN diodes placed at backward angles of 145°, 135°, and 125°, together with four additional detectors positioned at the forward angle of 35°. The student will contribute to the analysis of the experimental data, focusing on the calibration of the detectors and on the extraction of the barrier distribution for the investigated systems. The work will be conducted within the ROOT software framework, and therefore a practical knowledge of C++ programming is required.

JOINT EUROPEAN MASTER IN NUCLEAR PHYSICS

Academic Year 2025/2026

MASTER THESIS PROPOSAL

TITLE: **Solving the collective Schrödinger equation to study fission rates**

SUPERVISOR(S): W. Ryssens

SUPERVISOR(S) contact- email: wouter.ryssens@ulb.be Telephone: +32 2 650 35 71

UNIVERSITY/RESEARCH CENTER: Institut d'Astronomie et d'Astrophysique (IAA), Université libre de Bruxelles

ABSTRACT

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

For several decades now, the IAA of the ULB has been recognized internationally as a centre of excellence in the field of nuclear astrophysics; one part of this excellence is the continued development of large-scale models of nuclear structure for use in astrophysical applications; these models are i based on nuclear energy density functionals and aim to simultaneously describe many different properties of thousands of nuclei.

The accurate modeling of fission remains particularly difficult for microscopic models; this despite the role of fission processes in shaping the abundances of the heaviest elements in the Universe. One is forced to reduce the nuclear many-body problem to just a handful of collective coordinates: modelers thus calculate the energy of the nucleus as a function of its shape, from a compact ground state to a configuration consisting of two separate fragments. Today, all large-scale calculation of fission rates rely on semiclassical estimates for tunneling rates in this low-dimensional space.

The subject of this thesis is to try and move beyond the semiclassical picture. The student will start from available one-dimensional collective spaces predicted by the IAA's latest large-scale model; instead of relying on analytical formulas, the student will numerically solve the collective Schrödinger equation in this subspace.