



ERASMUS MUNDUS JOINT MASTER IN NUCLEAR PHYSICS

Academic Year 2026/2027

MASTER THESIS PROPOSAL

TITLE: *Development of the STRASSE and HYPATIA detector systems for the study of exotic nuclei.*

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ABSTRACT

Our group is involved in the development of two state-of-the-art detector systems – the STRASSE silicon tracker and the HYPATIA hybrid photon detector – for experiments in nuclear structure research at the RIKEN, Radioactive Isotope Beam Factory in Japan. The combination of these devices aims to enable simultaneous high-resolution gamma-ray spectroscopy and charged-particle (essentially proton) tracking to study nuclei with very asymmetric neutron-to-proton ratios – the so-called “exotic” nuclei. To produce and characterize the exotic nuclei of interest, quasi-free scattering (QFS) reactions are employed, whereby a single-neutron or proton is “knocked out” from the projectile.

The Master’s Thesis project will contribute to one or more aspects of the development of these devices and the associated experiments:

- **STRASSE data analysis:** contribute to the processing of data from in-beam commissioning and/or prototype detector measurements (timestamp reconstruction, tracking, etc.).
- **HYPATIA design simulations:** study the impact of various detector configurations on the gamma-ray response of the array (efficiency, resolution and Doppler reconstruction).
- **Quasi-free scattering event generator benchmarking:** compare basic QFS event generators with theoretical calculations, including effects such as the internal momentum distribution of the knocked out nucleon.

The different studies will require the student to employ nptool, a Root and Geant4 framework, for the simulations and data analysis developed in our group. They will improve and validate existing simulations and benchmark reconstruction algorithms using “Monte Carlo truth”. Ideally, basic skills in c++ and familiarity with ROOT would be beneficial.

By the end of the thesis project, the student will have gained hands-on experience with cutting edge detector simulation tools and data analysis for nuclear physics experiments. This will form an ideal basis for a PhD in nuclear structure physics and related fields.