# Surrogate reactions in inverse kinematics at heavy-ion storage rings*

B. Jurado[1], M. Sguazzin[1], M. Grieser[2], J. Pibernat[1], J. A. Swartz[1], J. Glorius[3], Y. Litvinov[3]
*et al.*
*[1]LP2I Bordeaux, France*
*[2]MPIK, Heidelberg, Germany*
*[3]GSI, Darmstadt, Germany*

Obtaining reliable cross sections for neutron-induced reactions on unstable nuclei nuclei is crucial to our understanding of the stellar nucleosynthesis of heavy elements and for applications in nuclear technology. However, the measurement of these cross sections is very complicated due to the radioactivity of the targets involved. The NECTAR (NuclEar reaCTions At storage Rings) project aims to circumvent this problem by using the surrogate-reaction method in inverse kinematics. A heavy, radioactive nucleus in the beam is to interact with a light, stable nucleus in the target to produce the compound nucleus formed in the neutron-induced reaction of interest via an alternative or surrogate reaction such as transfer or inelastic scattering. This compound nucleus may decay by fission, neutron or gamma-ray emission, and the probabilities for these modes of decay are to be measured as a function of the excitation energy of the compound nucleus. This information is used to constrain model parameters and to obtain much more accurate predictions of neutron-induced reaction cross sections [1].

Yet, the full development of the surrogate method is hampered by numerous long-standing target issues. The objective of the NECTAR project is to solve these issues by combining surrogate reactions with the unique and largely unexplored possibilities at heavy-ion storage rings. In these storage rings, heavy radioactive ions revolve at high frequency passing repeatedly through an electron cooler, which greatly improves the beam quality and restores it after each passage of the beam through the internal gas-jet serving as ultra-thin, windowless target. This way, excitation energy and decay probabilities can be measured with unrivaled accuracy.

In this contribution, I will present the technical developments and the methodology, which we are developing within NECTAR to measure for the first time simultaneously the fission, neutron and gamma-ray emission probabilities at the heavy-ion storage rings of the GSI/FAIR facility. In particular, I will present the first results of the proof of principle experiment, which we successfully conducted in June 2022 at the ESR storage ring of GSI/FAIR.

[1] R. Pérez Sánchez, B. Jurado et al., Phys. Rev. Lett. 125 (2020) 122502

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