Nuclear Physics Program to Be Developed at the DONES Facility Using Pulsed Deuteron and Neutron Beams*

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During the talk, the conceptual design of the experimental setup will be presented, highlighting the potential for an extensive nuclear physics program to be conducted at the DONES (DEMO-Oriented Neutron Source) facility. Special attention will be given to the feasibility and uniqueness of such measurements [1, 2].

DONES is poised to become a high-intensity neutron irradiation facility, developed as part of the European roadmap toward fusion-generated electricity [3]. Its primary objective is to investigate and qualify materials exposed to extreme neutron irradiation conditions, replicating those at the first wall of a fusion reactor. This facility will play a crucial role in paving the way for the future construction of the DEMO Power Plant, planned as the successor to ITER. Once operational, DONES will be the world's most powerful source of fast neutrons. This objective will be achieved by using 40-MeV deuterons accelerated to a 125-mA beam current. The deuterons will produce a high flux of neutrons via stripping reactions with a liquid-lithium target. A neutron flux with a density of approximately 10^{18}-10^{19} n/m^2/s and an energy of about 14 MeV will irradiate materials in the test cell.

For nuclear physics studies, a very small fraction of the deuteron beam can be extracted from the main beam and directed to hall R026, where it can either be used directly for nuclear physics experiments or converted into a pulsed neutron beam for studies involving neutron-induced reactions. The available space in hall R026 is approximately 60 x 36 x 8 meters, which is sufficient for several detection stations. Furthermore, the 60-meter distance is suitable for neutron time-of-flight (TOF) measurements. The time structure of the beam perfectly meets the requirements for gamma-ray spectroscopy studies. Several experimental campaigns are planned at DONES, such as: i) gamma spectroscopy of nuclei produced in fast-neutron-induced fission reactions, ii) investigation of pygmy dipole resonances (PDRs) via (n,n'γ) reactions, iii) half-life measurements of long-lived isotopes, iv) deuteron-induced reactions, and others.

The experimental program to be conducted in hall R026 will benefit from: i) continuous availability of a pulsed deuteron or neutron beam, ii) a specific and favorable beam time structure, iii) high deuteron beam intensity, iv) the potential for long-duration experiments. These conditions create an exceptional opportunity at DONES for planning advanced and unique nuclear physics investigations. Detailed information about the technique can be found in the "Report on Possible Complementary Experiments to Be Developed in DONES Using Deuterons", prepared within the DONES Preparatory Phase project [1].

[1] Ł.W. Iskra, B. Fornal, D. Cano-Ott, E. Mendoza *et al.*, "Report on possible complementary experiments to be developed in DONES using deuterons" (2021).

[2] A. Maj, M.N. Harakeh, M. Lewitowicz, A. Ibarra, W. Królas "White Book on the Complementary Scientific Programme at IFMIF-DONES" (2016).

[3] https://ifmif-dones.es/

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