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IFMIF-DONES: Experimental strategy for fusion materials qualification

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IFMIF-DONES (International Fusion Materials Irradiation Facility –DEMO Oriented Neutron Source) has been identified as a strategic facility in the European roadmap toward the achievement of fusion energy. Currently under construction in Granada (Spain) and expected to be operational in 2034, it will be the only installation worldwide capable of producing a high-intensity, fusion-relevant neutron flux based on deuteron–lithium (Li(d,n)) reactions. This flux, expected to reach densities of up to 10^{15} n/(cm^2·s), will be delivered in the central Test Cell through a modular configuration designed to accommodate multiple irradiation environments. The resulting neutron spectrum will closely reproduce that of a fusion reactor, enabling the accelerated testing of materials under well-controlled thermal and mechanical conditions.

The main objective of IFMIF-DONES is to enable the nuclear qualification of structural and functional materials for DEMO and future fusion reactors. The facility will deliver up to 20–30 dpa in 300 cm^3 within 2.5 full-power years (fpy) and 50 dpa in 100 cm^3 in 3 fpy. In its modular configuration, the primary irradiation system will be the High-Flux Test Module (HFTM), optimized for small specimen testing (SSTT) and initially dedicated to Eurofer97 and other RAFM steels, providing fundamental data on irradiation-induced hardening, embrittlement, microstructural evolution, and helium effects. IFMIF-DONES include other modules under development such as the Creep Fatigue Test Module (CFTM), addressing fatigue life reduction under neutron irradiation, the Tritium Release Test Module (TRTM), to quantify tritium release behavior from ceramic breeder materials, and other flexible irradiation modules for specialized experiments.

IFMIF-DONES is also planned to support complementary experimental applications in fields such as medical isotope production, gamma spectroscopy, time-of-flight measurements, and neutron-based industrial processes.

IFMIF-DONES will play a key role in the European fusion roadmap by providing the data needed to evolve from material development to operational components in future fusion reactors.

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