ENERGETICS

MUR DM 118 ex 351 - Tritium Technologies for the SORGENTINA-RF Facility

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Context of the research activity	Nuclear reactors present a harsh environment for component service , due to exposure to an intense fluence of high-energy neutrons. Degradation of materials in this environment can lead to reduced performance, and in some cases, early failure. The presence of neutron-induced radioactivity, however, can be useful tp produce radioactive isotopes for medical use. In the National Recovery and Resilience Plan (PNRR), the mission 6 on health sector supports scientific research in biomedical and health fields (p. 16 and p.231), such as the production of radioisotopes for medical purposes. Over 10.000 hospitals worldwide use radioisotopes for diagnosis or treatment of 35 million patients every year, of which 25% are European. Europe is the second largest consumer of technetium-99m, the most widely used diagnostic radioisotope. Several European research reactors involved in the production of medical radioisotopes are approaching the end of their lifespan, with the supply of medical radioisotopes becoming more fragile and leading to some severe shortages. Progetto finanziato dal MUR - DM 118/2023 - Dottorati generici di ricerca PNRR - CUP E14D23001620006
	ction has recently been undertaken to coordinate the operation of research reactors in the European Union and abroad and to minimise interruptions in radioisotope production. Despite these efforts, the issue of medical radioisotope capacity, especially in Europe, still requires full consideration by all stakeholders as it is essential to ensuring key medical diagnosis and treatments in the European Union. Objectives The experimental part of the PhD activity will be carried out mainly at the Brasimone ENEA Research Centre. The main topic of research deals with the design of the tritium processing system located in the Sorgentina-RF (SRF) plant. The SRF scope is the

Objectives	development and the optimization of 99Mo production routes that are alternative and complementary to those presently adopted. This radionuclide is the precursor of 99mTc used as tracer in “single photon emission computed tomography” (SPECT), a diagnostic technique that covers more than 80% of all the nuclear medicine diagnostic procedures worldwide. In particular, the Tritium Facility manages and recycles the Deuterium and the Tritium used in the plant. It dynamically controls their inventories and guarantees an adequate degree of safety calculating their permeation by means of transport models.The design of the tritium processing system is at an intermediate stage because the model describing the system (realized with SIMSCAPE) only has implemented the logic behind the isotopes management. It is now necessary to consider specific critical components and study their functioning and their performances developing proper models using COMSOL, and thereafter coupling the results with the SIMSCAPE one. Another necessary subject of research is the design of the vacuum lines placed inside the Tritium Facility: most of the systems present in the facility work in vacuum conditions and therefore it is mandatory to properly produce a suitable degree of vacuum. Being the system operated under vacuum conditions, a proper design of the vacuum instrumentation and components needs to be carried out, also with the aid of specific simulation tools such as Molflow+. Supporting this main research object there will be some additional activities related to the transport model already adopted for the study of SORGENTINA-RF facility. There will be both experimental and modelling parts related to tritium transport phenomena in fusion-relevant experiments. A pole of excellence for health and the environment, specializing in the development of advanced technologies in the fields not only of nuclear medicine and ionizing radiation for oncological diagnosis and therapies: this is the goal of SORGENTINA-RF, one of the three projects - accounting for a total sum of 6 million euros - that will be implemented in the ENEA Research Centre of Brasimone, 60 kilometres from Bologna, with positive economic and employment impacts both for the municipalities of the area and at a international level in the field of radionuclides. Canada’s decision to close the National Research Universal Reactor, the world’s leading producer of this nuclear medicine radioisotope, opens up very interesting and wide-ranging market prospects. This project aims to turn to best account the know-how and the large experimental equipment of Brasimone Research Centre to create innovative life-science products - a constantly expanding sector. Hence, ENEA’s decision to invest around 1.4 million euros to this end. Operationally speaking, the ENEA SORGENTINA-RF project foresees installation, at the Brasimone Research Centre, of a prototypical plant for industrial production of sodium molybdate containing 99Mo, an isotope of strategic value for nuclear medicine. The objective is to demonstrate the optimal quality of the final product and the economic sustainability of the process, in order to then attract private investors to build a local infrastructure for production and commercialization of 99Mo, under license from ENEA. According to initial estimates, the plant will ensure production of radionuclides equal to one third of the nationwide demand, for around 7 million inhabitants, and will create 70 highly specialized jobs. References: 1. Pietropaolo, A. et al., SORGENTINA-RF project: fusion neutrons for Mo medical radioisotope, Eur. Phys. J. Plus (2021) 136:1140. 2. E.U. Nuclear Illustrative Programme presented under Article 40 of the Euratom Treaty Brussels, 12.5.2017, COM(2017) 237. 3. Pietropaolo, A. et al., Feasibility study of an intense D-T fusion source: The

	new sorgentina", 10.1016/j.fusengdes.2014.01.058. 4. Contessa, G. M. et al., Preliminary evaluations of the environmental impact for the production of 99Mo by fusion neutrons, Eur. Phys. J. Plus (2021) 136:637.

Skills and competencies for the development of the activity	Excellent knowledge of nuclear reactors engineering and design and fusion reactors radiological safety. Knowledge of tritium transport simulation codes would be a plus