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DONES-ConP1 PROJECT: CONSOLIDATING THE START OF THE IFMIF-DONES CONSTRUCTION PHASE*

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Abstract

IFMIF-DONES is an ESFRI facility based on a 5 MW deuteron accelerator currently under construction in Granada (Spain) as part of the European roadmap to fusion electricity. Its main goal is to characterize and qualify materials under a neutron field with an induced damage like the one faced in a fusion reactor, developing a material database for the future fusion nuclear reactors. Moreover, a list of medium neutron flux experiments in other irradiation areas for fusion and non-fusion applications have been identified previously and are under analysis.

The construction phase was officially launched from March 2023, after setting up the steering committee for the DONES Programme composed of several countries. To support the preparation of the key documentation and consolidate contributions from parties, a set of tasks is being developed within the framework of the new DONES Consolidation Phase project (DONES-ConP1). In this contribution, the main objectives of the project such as the drafting of the acceptance tests for the procurement, the first version of the irradiation plan for fusion and non-fusion applications, or the update of key project documentation will be discussed.

THE DONES PROGRAMME

The DONES Programme started in March 2023 with the main mission of producing a database and benchmarking the effects on materials irradiated under fusion-like neutrons. For that the purpose, the IFMIF-DONES facility will be built under this framework.

The International Fusion Materials Irradiation Facility - Demo Oriented NEutron Source (IFMIF-DONES) [1,2] is a single-sited novel Research Infrastructure for testing, validation and qualification of the materials to be used in a fusion reactor (Fig. 1). It is based on a unique neutron source with an energy spectrum and flux tuned to those expected for the first wall containing future fusion reactors. Materials irradiation data under such conditions are of fundamental interest to the fusion community as those will feed and validate the modelling tools for materials radiation damage phenomena. The IFMIF-DONES will be a major step towards IFMIF [3] as it will develop a unique high-current high-duty cycle accelerator technology, liquid metal target technology and advanced control systems.

Figure 1: Mockup of the IFMIF-DONES facility site in Escúzar (Granada).

The original IFMIF project started in 1994 as an international scientific research program, carried out by Japan, the European Union, the United States, and Russia, and managed by the International Energy Agency (IEA). Since

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2007, it has been pursued by Japan and the European Union under the Broader Approach Agreement in the field of fusion energy research, through the IFMIF/EVEDA (IFMIF Engineering Validation and Engineering Design Activities) project, which conducts engineering validation and engineering design activities for IFMIF, including IFMIF engineering design, Validation Activities of the Lithium Loop System, Validation Activities of the Irradiation Area System, Validation Activities of the Accelerator System that is still on-going with the design of the LIPAc prototype for the low energy section (9 MeV) of the IFMIF deuteron accelerator.

IFMIF was first proposed to the ESFRI Roadmap in 2006 and finally included as the new IFMIF-DONES Concept in the ESFRI Roadmap of 2018. The development of the IFMIF concept was mostly carried out within the Broader Approach spanning from 2008, and the validation activities will last until at least 2025.

IFMIF-DONES is a simplified but upgradable half-version of IFMIF with an identical particle accelerator concept. It is based on a 40 MeV, 125 mA in continuous wave mode (CW) deuteron accelerator [4] (5 MW beam average power, instead of the 10 MW of IFMIF) hitting with a rectangular beam size (approx. 20 cm x 5 cm) a liquid lithium screen target flowing at 15 m/s – to evacuate the beam power – and generating a flux of neutrons of 10^{18} $m^{-2} \cdot s^{-1}$ with a broad peak at 14 MeV through stripping nuclear reactions, reproducing the expected conditions of fusion power plants. Materials are irradiated by the neutron beam as close as possible to the liquid lithium target to obtain damage rates of up to 15 atomic displacements per year (dpa/year) under temperature-controlled conditions. After a long irradiation period (up to two years), irradiated modules will be partially dismantled and the irradiated samples will be characterized.

EUROfusion and Fusion for Energy (F4E) started in 2015 a process to develop the engineering design of IFMIF-DONES and in December 2017, F4E positively evaluated the joint Spain-Croatia proposal to site DONES in Granada, Spain. By the end of 2019 and until 2021, a preparatory support action was awarded to Spain and other European countries to pursue a model for the governance, internal rules and financial aspects, as well as exploring technical alternatives and a complementary experimental programme. During March 2023, Spain and Croatia called for the first DONES Steering Committee in Granada, setting the start of the DONES Programme Construction phase (Fig. 2).

Figure 2: Picture of the current construction status of the DONES site.

DONES-ConP1

The DONES Consolidation Phase 1 Project (DONES-ConP1) is a two-years long European Project, successor of DONES Preparation Phase (DONES-Prep) Project linked to the EURATOM Work Programme. The main objectives of the project are: 1) the consolidation of the DONES Programme partners in the process of defining their contributions to the programme before national funds are available; and 2) the consolidation of a wide DONES Users Community, also exploring other scientific and technological areas.

The project is formed by ten European institutions and observers, key in the area of fusion technology development and interested in the DONES Programme. It is organized in several workpackages with different tasks which cover and develop the two main objectives of the project mentioned before in the following way:

- Developing an **experimental programme** in fusion and also expanding to non-fusion areas, associated to widen the DONES Users community.
- Completing the framework of the in-kind and partnership procurements for efficient collaboration between stakeholders by: assessing the **strategy of the in-Kind Contributions** (IKC's);
- By updating **key documentation** for policy-makers about financial, legal and organisational project organisation related to the international character of the IFMIF-DONES Facility during its construction and operation phases, including installation and commissioning.

THE EXPERIMENTAL PROGRAMME

One of the main objectives of the DONES-ConP1 is focused on establishing a mature users community of IFMIF-DONES and associated support facilities. The project will assess a priority list of experiments for both fusion and non-fusion applications, gathering the information from project participants and other communities. The project will involve as many entities as possible in the new DONES Users Community, including those which are now neither contributing nor involved in the DONES activities. DONES-ConP1 will assess as well the needs of the scientists in terms of data and remote access, and how the facility will manage it, providing a draft of the DONES Data Policy.

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Fusion Programme

The development of a DONES Fusion Experimental programme for DEMO users and non-DEMO ones is one of the main priorities for the DONES Programme, ensuring that the requirements are properly integrated in the present baseline by interfacing between machine designers and user's requirements. In that perspective, the project is studying the different alternatives of irradiation modules. The most relevant will be included in the irradiation plan to be issued during this project. The project is also reinforcing the coordination between machine and users' requirements in order to ensure the inclusion of users requirements on the facility design.

Non-Fusion Programme

During DONES-ConP1, the non-Fusion Experimental programme will be pursued, defining and designing the areas outside of fusion research, always ensuring no negative impact in the DONES Fusion Experimental Programme. Several experimental activities were already identified as cutting-edge during DONES-PreP in their respective areas of research, such as a nTOF facility for nuclear physics, the production of radioisotopes with expected shortage in medium term like Tc-99m for nuclear medicine, or test stations for industry. These experiments will be further analyzed during DONES-ConP1.

DONES Users

A DONES Users Group has been established, combining priority fusion research users and others outside fusion research for the Complementary Experimental areas under development with the objective of funnelling the experimental proposals, assess them and select the most appropriate ones. The group has already established a series of workshops in which all the experimental proposals are discussed altogether. The second one in Granada (Fig. 3) was a success, and the third workshop of the series will be held in October 2023 [5], organized within the framework of the DONES-ConP1.

Figure 3: Participants in the second DONES Users Workshop in October 2023.

IKC STRATEGY

Within DONES-ConP1, the full development of a strategy of acceptance tests for the supply of the IFMIF-DONES components will be implemented. It shall benefit from the experience of the project partners in other facilities to improve the present approach in terms both legal aspects and on the technical side (list of packages, acceptance tests,…). Discussions with alike pan-European Research Infrastructures will be organized to share the experience on all these aspects.

A lot of In-Kind or commercial procurement are expected to be signed in the following years by the DONES Programme Team, and therefore, through Procurement Agreements, which are presently under development within the framework of the DONES Programme. One of the main critical aspects of the IKC's are the definition of the Acceptance Tests to confirm the validity of the deliverables within a certain contract. It is thus essential to agree on and validate, the strategy of the Acceptance Tests for each equipment. DONES-ConP1 will advise on this strategy based on the previous experience of each partner, issuing the report Strategy of Acceptance Tests at DONES. The final mission of the group will be to develop, package by package, the bunch of acceptance tests to be included in each card.

KEY DONES DOCUMENTATION

The project will consolidate some of the most important documents of the project: the organisation, the CODA documents and transport and safety documentation. There are different alternatives that could be implemented in order to structure the DONES Programme Team (Fig. 4) during the lifetime and careful discussion is advisable between all the different partners involved in the project.

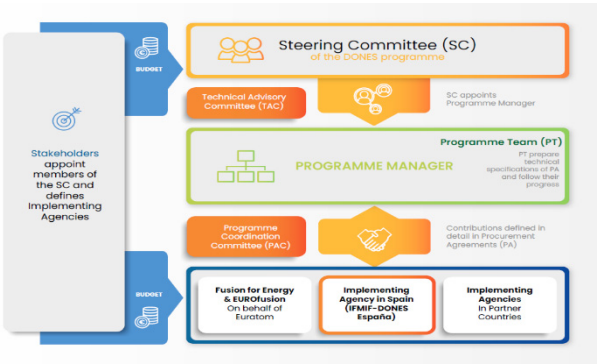

Figure 4: Current DONES Organisation approved by the DONES SC.

CONCLUSIONS

DONES-ConP1 offers a unique tool for providing the framework for consolidating the DONES Programme in the next years. The project will provide a draft of the experimental programme, expand the users community, create the strategy of acceptance tests and update key project documentation.

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