

Fusion Technology Group (FTG) Evaluation

FTG employs four permanent researchers, one technician, five post-doctoral fellows and six PhD students. The gender balance is 6 females and 10 males. The FTG team has been able to attract an increasing number of students (master/undergraduate and PhD) and postdoctoral researchers showing very good training and mentoring capabilities.

1. Scientific excellence / originality of the research conducted by the group.

The Group brings together researchers and graduate students with expertise and research interests in radiation physics and material science. Their aim is to promote interdisciplinary research in fusion technology. FTG participates since 1999 in the European Fusion Program and investigates materials at extreme environments and novel aspects of applied radiation physics. The group activities focus on the development of radiation resistant materials for the fusion power-demonstration-plant DEMO and contribute to its safety analysis. Aspects of material stability, reliability, life cycle and radiological properties under fusion power plant conditions are thoroughly investigated. FTG contributes to ITER and DEMO nuclear analysis and works to improve their neutron measurement capabilities. These activities also benefit space research, energy systems development and nanotechnology applications. They extend to the development of novel radiation technologies in biomedicine and cultural heritage studies.

Specifically, FTG pursues three areas of investigation: 1. Fusion technology with emphasis on radiation damage of material, the interaction between plasma and plasma facing materials, neutronic calculations and measurements of fusion devices, the development of neutron detectors, the analysis of operational radiation exposure and plasma diagnostics in fusion devices. 2. Radiation Physics, with emphasis on the development of new technologies for neutron-based cancer treatments, radiation protection, radiation shielding optimization and operational radiation protection in nuclear facilities. 3. Materials at extreme environments for fusion energy, aerospace and nanotechnology applications, including the characterization of fusion-material properties, thermal protection systems for aerospace applications and the characterization and fabrication of nanomaterials.

FTG has grown sensibly in the reporting period and has acquired an important role in the fields of material development, neutronics and safety for fusion at European level thanks to its expertise and infrastructures. It also coordinates a larger group of scientists from INPP and INN integrated in the Fusion Technology activities. In the reporting period FTG made important achievements in studying neutron irradiation effects on the mechanical and structural properties of Fusion DEMO materials, in understanding of plasma interaction with ITER-like wall plasma facing materials, and the scientific exploitation of JET operation with D-D, T-T and D-T plasmas.

2. Quality of the publication record and the funding record of the Group.

The FDG group published during the reporting period 81 papers and made about 90 presentations in scientific meetings and gatherings. The Group collected 1245 citations. This record is good. Total external funding during the review period for the work carried out by the group was on average ~700 k€ per year, which is excellent overall. The Review Panel recommends FDG to enhance efforts in the future to maintain and increase this level of activities while placing increased emphasis on publications. European funding in the Group has grown significantly from 2018, with exception of 2021 probably due to delays in the start of Horizon Europe program.

3. Quality of the National and International collaborations of the Group.

Members of FTG have been active in running the Institute's Research Reactor (Reactor Manager, Radiological Officer) and have Nuclear and Radiological activities, either on their own or connected with the Fusion Program. FTG coordinates the NCSR "Demokritos" Fusion Technology Research Team consisting of about 20 scientists from different Institutes of the Centre. The Group has established collaborations with a large number of Research Centers, Universities and Industries worldwide, demonstrating a positive collaborative approach, sense of initiative and the capability to leverage the group resources and competences to enhance its scientific output.

Universities, Large Scale Facilities and Industries in the field of Fusion Technology, Aerospace, Materials Science, Nanotechnology and Radiation Physics are found in the list of their collaboration partners, and is also reflected in the number of co-authored publications and collaborative European research projects. There is also active participation in national and international scientific societies and in standardization bodies.

Overall the above collaborative activities are outstanding and attest to the recognition of the members of the FTG group nationally and internationally.

4. Quality of strategic plan and validity of future goals.

The FTG has been capable to increase significantly its experimental capabilities with upgrades, new installations and new developments concerning laboratories and facilities. The plan to expand them further to be able to handle radioactive materials is strategically important as it will meet the needs of the international fusion community.

FTG plans to continue to contribute to the European Fusion program through the participation in activities of Eurofusion and Fusion for Energy (F4E), designated to provide the European contribution to ITER, the world's largest scientific partnership that aims to demonstrate fusion as a viable and sustainable source of energy. In particular, FTG will participate in the scientific and technological exploitation of Europe's flagship device, JET, which supports ITER by exploiting the unique opportunities provided by the planned JET experimental campaigns until the end of 2023. Also, the European research effort towards the construction of a Fusion energy producing device, DEMO, is presently continued in Horizon and FTG has secured funding till the end of 2025, thus, the financial European support to the group for Fusion related activities is guaranteed for the next five years.

The strategic plan outlined in the report appears well thought out, covers all key areas of FTG's activities and prepares well the group for the coming four years.

5. Overall Evaluation of the progress during the past period years and potential for future growth

In the reporting period the Fusion Technology Group has carried out excellent and original research activity covering key aspects of the international scientific and technological fusion energy development. The FTG has participated with significant contributions in the implementation of the European Roadmap to Fusion Energy, as shown by the funding received from EU grants. The scientific output, in term of innovations and of publications, has been good, also thanks to the excellent capability to attract students and young researchers and to establish collaborations within NRC and worldwide. FTG has demonstrated the ability to manage projects for achieving objectives and to use optimally available resources.

The strategic plan of the Group is fully in line with the European fusion program. The areas covered, namely radiation damage studies on fusion materials, nuclear measurements and analysis, and safety

studies, are key in these efforts and will grow in the future. The plan to expand further the infrastructure to be able to handle radioactive materials is strategically important as it will meet the needs of the international fusion community. The Review Panel feels that FTG would have the potential to expand further its activities, if more human resources were available.