The BiGyM Project: Status and Perspectives

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GyM [1] is a linear plasma device (LPD) operating at Istituto per la Scienza e Tecnologia dei Plasmi, CNR, Milan, with the aim of studying the plasma-material interaction (PMI) for magnetic confinement nuclear fusion applications. GyM is part of the portfolio of the EUROfusion facilities and one of the LPDs of the EU Contracting Party involved in the IEA Technology Collaboration Programme on PWI.

This contribution reviews the upgrade of GyM, named “BiGyM”, currently underway as part of the NEFERTARI project funded by Next Generation EU. The aim of the upgrade is to extend the accessible parameter space from plasma densities of 10^{16}–10^{17} m^{-3} and ion fluxes of 10^{20}–10^{21} $m^{-2}s^{-1}$, suitable for reproducing the ion and charge-exchange neutral fluxes impinging on the main chamber wall of tokamaks, such as ITER, towards 10^{18}–10^{19} m^{-3} and 10^{22}–10^{23} $m^{-2}s^{-1}$, which are more representative of divertor conditions. This will be achieved by installing two helicon plasma sources, each delivering 10 kW of power via 13.56 MHz RF birdcage antennas [2]. In addition, a new sample exposure system has been developed to reproduce the operating conditions of ITER divertor plasma-facing components by heating the samples up to 1500 K and applying a negative bias voltage down to –300 V, thereby enabling precise control over the energy of the incident ions. Finally, GyM’s PMI diagnostic capabilities will also be enhanced through the implementation of a picosecond laser-induced breakdown spectroscopy (ps-LIBS), enabling *in situ* characterization of material composition changes and hydrogen isotope retention. With the procurement phase set to conclude by October 2025, BiGyM is expected to achieve first plasma and PMI experiments in early 2026.

In support of this upgrade, a dedicated modelling framework has been developed to predict BiGyM plasma behaviour and assist future experimental interpretation. Current activities encompass: (i) modelling of helicon wave propagation with COMSOL Multiphysics, (ii) prediction of plasma density, temperature, and particle flux profiles via the tokamak edge SOLPS-ITER package, and (iii) investigation of sputtering and material migration using the ERO2.0 code. The ultimate goal is to couple the three tools into an integrated workflow capable of comprehensively simulating PMI experiments in BiGyM, from plasma generation to the topographical modifications on sample surface. Additionally, (iv) COMSOL-based simulations of laser–material interaction processes have been carried out to support the interpretation of future ps-LIBS measurements. This contribution will also briefly present the main outcomes of the ongoing modelling activities, providing a first insight into the expected performance of BiGyM.

[1] A. Uccello, et al., Front. Phys. 11, 1108175 (2023)
[2] Ph. Guittienne, et al., Plasma Sources Sci. Technol. 30, 075023 (2021)

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