Testing of a large Non-Evaporable Getter pump mock-up in view of application in modern Neutral Beam Injectors

Fabrizio Siviero1,*, Michele Mura1, Beatrice Busetto1, Enrico Maccallini1, Paolo Manini1, Emanuele Sartori2, Marco Siragusa2, Piergiorgio Sonato2, Stefan Hanke3, Christian Day3

1SAES Getters S.p.A., Viale Italia 77, 20020 Lainate, MI, Italy
2Consorzio RFX, Corso Stati Uniti 4, 35127 Padova, PD, Italy
3Karlsruhe Institute of Technology (KIT), Institute for Technical Physics (ITEP), 76344 Eggenstein-Leopoldshafen, Germany

*corresponding author: fabrizio_siviero@saes-group.com

Neutral Beam Injectors (NBI) are key subsystems of facilities for nuclear fusion research. These machines need effective pumping systems for hydrogen and its isotopes, up to several hundreds of m$^3$/s. In addition, the future use in demonstrator plants like DEMO poses further requirements related to availability, maintenance and safety. To face these technical challenges, some years ago a collaboration started between SAES, Consorzio RFX and KIT aimed at investigating the performances of very large Non-Evaporable Getter (NEG) pumps for this purpose.

SAES selected a Zr-based alloy named ZAO®, in the form of porous sintered disks, as getter material. Its fundamental strengths are the high affinity for hydrogenic species, the large sorption capacity and the high mechanical resistance to repeated H$_2$/D$_2$ loading and unloading [1]. Different pumps of increasing size from 0.1 to 1 m$^3$/s were studied by simulations and experimental campaigns with RFX before designing and assembling a large-scale mockup, featuring nearly 20 m$^3$/s for hydrogen. The SAES NEG pump was successfully tested in the TIMO facility at KIT with both hydrogen and deuterium. In particular, the results include: i) a characterization of the pumping speed vs H$_2$/D$_2$ concentration at different throughput and getter temperatures; ii) a study of the regeneration process, i.e. hydrogen extraction; iii) the thermal management of an array of cartridges.

These data will act as guidance for the design of full-size pumps for fusion research facilities, taking advantage of the modularity of the NEG pumping system, which simplifies the scale-up and allows distributing the pumping speed according to the available space.