# Large Non-evaporable Getter pumps for application in Nuclear Beam Injectors: from conceptual design to manufacturing

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The operation of modern Neutral Beam Injectors (NBI) poses several technical challenges related to the pumping system, both in terms of pumping speed (hundreds of $m^3/s$) and capacity. Non-evaporable Getter (NEG) materials present unique features which are appealing for application in fusion devices, in particular following the recent development of pumping elements based on ZrVAlTi alloys. These getters, in the form of porous sintered disks, display high affinity for hydrogenic species, large capacity and strong mechanical resistance to repeated $H_2/D_2$ loading and unloading. Moreover, NEGsô working principle itself prevents uncontrolled hydrogen release in case of power outage or subsystem failure, unlike cryopumps, resulting in increased safety.

The feasibility of a full-scale NEG solution was studied both with experimental investigations and simulations (AVOCADO code), aimed at validating scaling laws to describe the behavior of very large pumps. Adsorption and regeneration (i.e. $H_2$ extraction) tests were performed on getter disks and NEG cartridges of increasing dimensions, in conditions relevant for NBI application [1], and complemented with simulations. Based on these data, the conceptual design of a significantly large mockup pump was completed: the mockup is expected to deliver 45 $m^3/s$ for $D_2$ at 0.02 Pa and will be tested in 2019 at the Karlsruhe Institute of Technology. The construction is at advanced stage, and mechanical and electrical aspects of its realization will be presented, together with a brief discussion of possible working scenarios.

[1] F. Siviero et al., *Fusion Engineering and Design*, (2019), DOI 10.1016/j.fusengdes.2019.03.026