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Concept Design of a Novel Superconducting PTO Actuator for Wave Energy Extraction

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There is a huge energetic potential associated to ocean waves, expressed in terms of the power per wave meter length that can be harvested, up to 60-80 kW/m in many areas near to the shore of populated areas. Among the different devices proposed to extract that power, the most extended ones are the Point Absorbers, based on the linear displacement between two bodies for which the use of electric linear generators is the best option since the conversion is done in a single-stage process. Nevertheless, the generation is done at low speed and hence big forces are required. Having actuators capable of exerting big forces also allows the Point Absorber to modify its natural frequency of oscillation and to better adapt to different sea states increasing its energy extraction capability.
Unfortunately, high forces are associated to high Joule losses which must be limited oversizing the generator. In this regard, the use of a superconducting actuator becomes especially convenient since it can handle very high currents with restricted losses and a small volume.
Previous considerations led different partners to present the SEA TITAN project to the H2020 LCE Call, which was finally granted. One of the aims of the project consisted in developing a non-superconducting machine while a second one was to perform a conceptual design of a superconducting novel actuator which is the subject of this paper.
The actuator is a reciprocating Cylindrical Switched Reluctance Machine based on MgB2 superconductor and a novel refrigeration system which includes an expandible cryostat and a Cryogenic System based on recirculating a flow of helium which is cooled down using a two-stage cryocooler.
The paper includes the calculations of the machine and the description of how the principal components have been conceived.

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