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Dynamic simulations of the cryogenic system of a tokamak

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Power generation in the next decades could be provided by thermo-nuclear fusion reactors like tokamaks. There inside, the fusion reaction takes place thanks to the generation of plasmas at hundreds of millions of degrees that must be confined magnetically with superconductive coils, cooled down to about 4.4K.

The plasma works cyclically and the coil system is subject to pulsed heat loads which have to be handled by the cryogenic refrigerator cooling the superconductive coils. By smoothing the variable loads, the refrigeration capacity can be set close to the average power; optimizing investment and operational costs.

In the framework of the Broader Approach for ITER, CEA is in charge of providing the cryogenic system for the Japanese tokamak (JT60-SA), which is currently under construction in Naka. The system has been designed to handle the pulsed heat loads.

To prepare the acceptance tests of this cryogenic system foreseen in 2016, both dynamic modeling and experimental tests on a scaled down mock-up are of high interest for assessing pulsed load smoothing control.

After explaining HELIOS test experiments, a dynamic modelling of the cryogenic system of the Auxiliary Cold Box (ACB) of the tokamak is presented, with results on the pulsed load scenarios. The model has been built up using ad hoc coded components starting from industrial data.

The final goal is to realize a complete simulator of the helium distribution system in order to get a predictive tool that can be used to test multiple scenarios and controls. The same tool could also be adapted to any tokamak and used throughout the study of future fusion reactors operation.

All the simulations have been performed with EcosimPro® computational software and the associated cryogenic library: CRYOLIB.

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