Tipo di tesi: Laurea Magistrale

Tipologia: teorica e numerica

Titolo della tesi: Design of the DTT thermal shield

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Argomento della tesi:
DTT is one of the largest superconducting tokamak under construction with the mission to get scientific and technological proofs of power exhaust in prospect of the first nuclear fusion power plant [1, 2]. The 5.5MA maximum plasma current, 6T toroidal magnetic field at the plasma center, and 2.19m plasma radius make DTT a flexible and compact facility for testing D-shaped plasmas with different configurations of heat load spreading.
The mechanical systems of DTT are designed and integrated analysing interfaces consistently with machine operating states including plasma operation, disruptions, baking, seismic event, testing, and maintenance.
A Thermal Shield (THS) is foreseen inside the vacuumed cryostat of DTT to minimize radiative heat loads from the tokamak warm components to the cold component of the Superconducting Magnets system at 4.5 K. The THS is electrically divided into segments in toroidal and poloidal directions to avoid eddy currents during plasma transient scenarios and disruptions.
The Thermal Shield will be made of silver plated single wall stainless-steel panels, each about 20 mm thick. The wall, 3 mm thick, is integrated in a stiffening frame placed at the panel edges. The panels are actively refrigerated by means of circular tubes welded to the panel wall. The cooling tubes are fed by pressurized helium gas. The PTS is a port shaped shield mechanically connected to the VVTS and CTS. A multilayer insulator is foreseen at the cryostat inner surface to reduce the radiation heat load on it.
The Thermal Shield cooling system is subdivided into 36 parallel cooling lines that independently covers a complete 10-degree toroidal sector of the THS.
Thermal radiation to the superconducting magnets is minimised by operating the Thermal Shield in the temperature range of 80-120 K and providing surfaces with low emissivity. High vacuum in the cryostat chamber (1x10-4 Pa) minimises free molecular gas conduction.
The proposed activity foresees a contribution to the foreseen developments using modelling and analysis tools: 1D system analysis of the helium circuit will provide design solutions for tube rooting integrated with technological and manufacturing requirements; 3D CAD modelling of THS sectors considering installation and assembly requirements; 3D thermo-mechanical analysis to verify the design of components, in particular of centring and supporting structures, under the machine operating states against design rules.

References
[1] R. Ambrosino, “DTT - divertor tokamak test facility: A testbed for DEMO,” Fusion Engineering and Design, vol. 167, p. 112330, 2021
[2] R. Martone, R. Albanese, F. Crisanti, A. Pizzuto, P. Martin Eds.. “DTT Divertor Tokamak Test facility Interim Design Report, ENEA (ISBN 978-88-8286-378-4), April 2019 ("Green Book")”

Data proposta: 21/03/2022

Stato: assigned

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