Contribution ID: **36** Type: **Oral or Poster**

Main Requirements of the Divertor Tokamak Test (DTT) Cryogenic Plant

Thursday 30 October 2025 11:30 (15 minutes)

The Divertor Tokamak Test (DTT) -https://www.dtt-project.it/- is an experimental facility currently under construction in Frascati (Rome, Italy), designed to investigate the challenges of heat exhaust under operating conditions representative of commercial fusion power plants, [1]. In order to ensure its relevance to ITER and DEMO, DTT must be capable of sustaining sufficiently long plasma pulses, which necessitates the use of a superconducting magnetic system. Consequently, DTT requires a dedicated Cryogenic Plant (or CryoPlant) capable of providing thermal control to the magnets and associated systems.
The cryogenic users in DTT are grouped into three temperature levels:
• 4.6 K helium is supplied to the magnets—including 18 Toroidal Field (TF) coils, 6 Poloidal Field (PF) coils, 6 Central Solenoid (CS) modules and a HTS insert—as well as to their supporting structures, thermal anchors and feeders. Additionally, cryopanels operating at this temperature are necessary for ensuring helium and hydrogen adsorption inside the plasma chamber;
• 50 K helium is supplied to the High Temperature Superconducting (HTS) current leads;
• 80 K helium is supplied to the thermal shields and chevron baffles, which protect the magnets and the cryopanels from excessive radiative heat loads.
During DTT operations, the cryogenic users are expected to demand a total cooling capacity of approximately 10 kW of equivalent power at 4.5 K. The most demanding operational state is the Plasma Operation State (POS), where magnets are subjected to peak heat deposition due to AC Losses (hysteresis and eddy currents during plasma current ramping) and nuclear heating. The Cryogenic System shall be able to handle the variable loads, as well as the static and continuous loads coming from resistivity losses and thermal radiation of the warmer surrounding components, [2].
This poster provides an overview of the thermohydraulic heat loads, duty cycle and process requirements of the DTT Cryoplant across its various operational states.

[1] F. Romanelli, “Divertor Tokamak Test facility Project: Status of Design and Implementation.,” Nuclear Fusion , no. 10.1088/1741-4326/ad5740 , 2024.
[2] F. Lisanti , M. Angelucci, R. Bonifetto, A. Froio, R. Zanino, A. Frattolillo, S. Migliori, P. Roussel, M. Frederic, D. Duri and A. Iaboni, “esign of the cryogenic loop for the superconducting toroidal-field magnets of the Divertor Tokamak Test,” Cryogenics 136 (2023) 103757.

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Track Classification: Cryogenics in Big Science