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Starting DTT infrastructures construction at ENEA Frascati Site

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The DTT (Divertor Test Tokamak) is being built and, while several of the main components are in various stages of manufacturing, now the complex of civil infrastructures and services necessary to host the machine and its auxiliary plants is ready to start construction. DTT largely reuses the former FTU complex but requires also the construction of additional new buildings and infrastructures. The civil design has been completed, having care to integrate all plants and subsystems in an overall 3-D plant integration model using advanced 3-d modelling, to be progressively developed into a full-fledged Product life cycle management (PLM) model. Careful analyses of the integration of civil works with the tokamak machine, additional heating systems (ECRH, ICRH and, at a later stage, NBI), electrical and water-cooling systems, cryoplant, assembly facilities, diagnostics and control system, logistics areas are deemed to optimize the concurrent activities and limit changes and rework.

The new building complex, the tender of which has been released in January 2025, features 150 000 m^3 of new constructions including the new Tokamak Hall Building, the ECRH Additional Heating Building (ECRH and associated power supplies), the Water-Cooling, Power Supplies and Diagnostic buildings. The erection of these 9 new buildings will be preceded by important excavation (74 000 m^3) and soil consolidation activities that will substantially change the current layout and configuration of the ENEA Center in Frascati.

The existing FTU buildings (now fully cleared from previous equipment), after refurbishment, will host all the cryoplant (compressors hall and ACB and RCB), ICRH power supplies, facilities for assembly preparation and rehearsal etc. The design was supported by a careful analysis of the applicable urban planning regulations, and the necessary variants and strategies for obtaining all construction permits, were shared with the competent Authorities, quickly achieving the objective. Aspects closely related to the specific characteristics of the context and the radiogenic activity were examined in depth, allowing the acquisition of additional specific permits by conducting preliminary investigations essential to the design, such as detailed geological and seismic analyses, environmental studies, archaeological and radiological surveys.

The design of the buildings has been carried out with a focus on minimizing emissions into the environment, ensuring that water resources are not impacted by using a recirculating cooling system and preventing the emission of radiation outside the buildings. A detailed constructability plan has been developed, resulting in a realistic construction phasing, that allows to match the restricted construction space while respecting the constrains of an anthropized area. The plan integrates logistical and accessibility considerations and outlines the site construction organization activities such as excavation, containment structures, new roads and ramps, underground networks and demolition, along with the construction of key buildings. Special focus has been given to the installation of electrical and specialized systems to ensure integration with the infrastructure.

Fig. 1 – Render of new buildings.

The new machine has required a substantial increase of the electrical power delivered to ENEA Site and for this purpose TERNA, the Italian Transmission System Operator, has started the lay down of two new 15 km high-voltage underground lines connecting the main electrical network node of Roma-Est to a new 150-kV grid switchyard close to ENEA Center. From this new switchyard, an underground cable are going to reach the new DTT substation (funded by Region Lazio - the Latium Regional government) where two step-down transformers for pulsed loads with operating power range from 80 MVA up to 110 MVA and two 20 MVA stepdown transformers for the steady-state loads will supply 20 kV to be distributed to 5 substations strategically located in the DTT site to match power demand of 29 MVA Steady State Power and 198 MVA Pulsed Power. Furthermore, in order to comply with the National Electricity Grid Code, measures will be implemented to mitigate the power factor and guarantee power quality. A new connection to MV Italian National Grid are arranged to supply the construction site and facilities supporting DTT, while maintaining energized all existing power loads of the ENEA Center. The design is complete and ready for tender.

To match the schedule of the DTT superconducting magnets a Frascati Coil Cold Test Facility (FCCTF) has been prepared also by refurbishing existing ENEA infrastructures as the He refrigerator. The FCCTF is equipped with the TF power supplies with an operating current of 44 kA, and a fast discharge unit (FDU) based on silicon-carbide (SiC) varistor in order to perform cold tests on each Nb3SN (TF, PF and CS) superconducting magnet. Now, the TF power supply, have been delivered to the FCCTF and being in the commissioning phase. The new cryostat, able to accommodate all the coils to be tested, is contracted and will be delivered and commissioned in 2026.

The design of the water-cooling and other utilities systems (i.e. nitrogen and instrument air) has been completed and components have been developed to a level allowing, now, a final phase of detailed design, in which optimization of the assembly inside buildings with restricted overhead and side spaces can be performed to reduce installation times and costs. A secondary cooling water system includes circulation and distribution pumps, chillers, storage vessels, piping and activated water treatment packages. A primary cooling circuit, which serves the divertor, first wall, vacuum vessel, ECRH, ICRH, power supplies and diagnostics, is composed by circulation pumps, heat exchanges, electric heaters, piping and mechanical filters. Other auxiliary systems, such as instrument air and nitrogen, are also integrated into the design, along with a comprehensive instrumentation and control system. In addition to these elements, the design included the reutilization and complement of existing LN2 tanks and distribution piping, together with helium storage tanks installation and external cryolines routing.

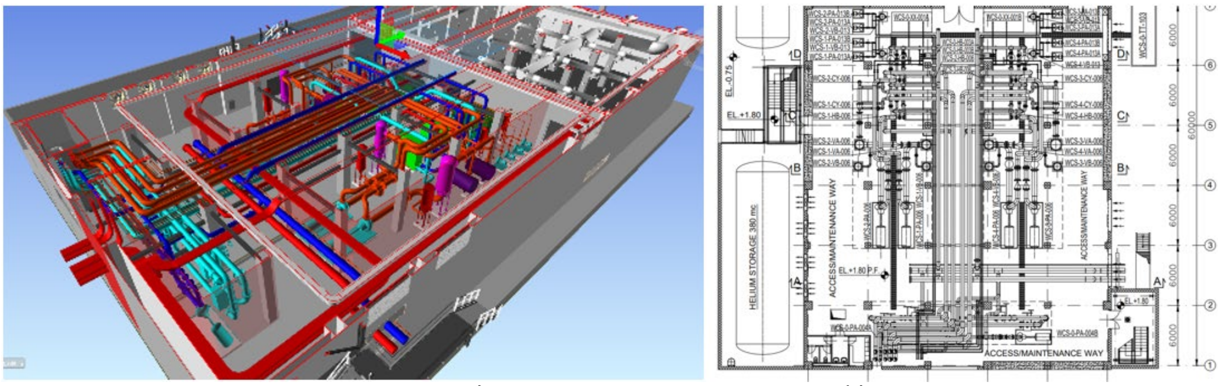

Fig. 2 – Auxiliary system piping 3D view and layout.

Logistic studies have been performed for the route allowing main loads, from generic manufacturing sites, either in Italy, Europe or outside Europe, to reach the DTT site, involving multimodal transports (ship, barge, trucks or specialized transport vehicles), roads and bridges reinforcements or temporary block, temporary storage on-route, on-site or ex-site.

While the start of construction activities has been delayed, due to a combination of external factors (mainly the COVID pandemics and results of the geotechnical and environmental surveys) and reorganization of the DTT management, now the project has taken advantage of this time to produce a mature infrastructures design. which has good changes to proceed according to plans or in any case not suffering of delays due to incomplete interfaces and reworks. *Keywords:* DTT, Frascati Divertor, Test Tokamak, ENEA, ENI