# The DTT Project and its impact on Italian industry

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Industrial Opportunity days 2023

15-16June 2023

INAF Osservatorio Astronomico di Capodimonte

DTT Consortium (DTT S.C.a r.l. Via E. Fermi 45 I-00044 Frascati (Roma) Italy)



















Company overview DTT in the European programme Status of the construction Civil work and Electrical Distribution System Machine components Auxiliary systems Elaboration of the research plan

# **DTT Company Overview**



DTT scarl (Società Consortile a Responsabilità Limitata) is a legal entity created to build and operate the DTT

Capital investment: 614M€ secured by ENEA. 55M€ grant awarded in 2022 on PNRR funds. 170M€ running contracts.

Operating costs: 130M€ shared pro-rata among the shareholders for engineering, research and operating costs.



ENEA will remain owner of the facilities; DTT Scarl is configurated as a Public Company (under the Italian law "Codice Appalti"); the applicable scheme is inside "Settori Speciali"

# Main latest development



EPIC contract among ENEA, ENI and DTT signed in December 2022. Contracts with all the shareholder in place.

After approval by the Ministry of Environment and Energy Security in January 2023, TERNA has started the realization the 150 kV line.



Dr.P. Barabaschi Prof. S. Cowley Dr. A. Grosman Dr. K. Hesch Prof. J. Li Dr. Y. Kamada Prof. D. Whyte CAS DEPPL CEA KIT CAS OST OFFIC AND TECHNICAL COMMITTEE APPOINTED IN DECEMBER 2021. Three meetings held in 2022.



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#### DTT Assetto macro-organizzativo



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### **DTT organization**



# EU Roadmap: Power exhaust a main relation by the second se





DTT is aimed to provide a <u>unique, flexible</u> <u>integrated environment, relevant to DEMO</u>, where all the relevant approaches can be tested.

Up to 60MW/m<sup>2</sup> in a power plant ~ heat flux on the surface of the Sun!





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### Torus hall integration and assembly



### **Electrical Distribution Systems**







## Render of new buildings layout

✓ "Progetto definitivo" of new cryoplant buildings being revised. DTT hall  $\checkmark$  In parallel: JC converters ✓ prequalification of industries  $\checkmark$  selection of verification contractor. building ✓ preparatory activities (new gates, demolitions, etc.) being launched ✓ "Appalto integrato" to be launched in 2023 after design verification/validations

# Toroidal Field coil system in the manufacturing stage





### **TF** superdummy







Compaction of superdummy conductor

Cross section of qualified conductor













### Vacuum vessel and ports





Call for tender imminent

Main characteristics:

- Double wall structure in 316LN
- Water (borated later) in the intershell as neutron moderator
- 6 gravity supports + 82 ports
- Mass: 37 ton (vessel body, 185 ton all)
- Dimension: OD 6.8 m, ID 2.5 m
- Sectors: 2 X 170° + 1 X 20°

Procurement strategy:

- 18 months for engineering and prototype qualification
- 18 months for production of sectors
- delivery of port ducts and bellows a few months later

### Poloidal Field coil system design completed





Call for tender to be launched summer 2023

### $PF1/6 - Nb_3Sn (Luvata):$

- Bmax = 9,1 T
- I=10,2 MAt (Nt=360)
- M=15 ton
- D = 3,3 m

### PF2/5 – NbTi (Furukawa):

- Bmax = 4,2 T
- I=4,3 MAt (Nt=160)
- M=16 ton

### PF3/4 – NbTi (Furukawa):

- Bmax = 5,3 T
- I=5,6 MAt (Nt=196)
- M=28 ton

### **Central Solenoid**

Different solutions being investigated following the magnet assessment. Decision first half 2023

# **Divertor engineering design on-going**





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### **Schedule for divertor manufacturing**



	2023				2024				2025				2026				2027			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	
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### In-vessel Coil Power Supplies (funded through PNRR-DTTU project)



CfT summer 2023

# RH facility (funded through PNRR-DTTU project)



A Physical and Virtual Training Facility will be built in support to the development and validation of the remote handling maintenance activities to be performed in the plant and to the design of the RHS as well, and It will be possible to simulate collaborative manipulators and rescue.



#### Hyrman

Two HYPER REDUNDANT MANIPULATORS (HyRMan) designed to operate through dedicated access port port#3 in the sectors 1, 5, 10, 15, to handle OFW. TFW, IFW (together with a dedicated cask

- **Estimated payload**: 300 kg
- □ Reach (inside tokamak): 5.6 m (joint 12 Along VV equatorial line
- 3.0 m for planar part
- 2.6 m for dexterous part



CfT September 2023

### Assembly strategy





The KSTAR/JT-60SA assembly strategy has been chosen instead of the original ITER-like. Recovering of time with respect to the end of the assembly achieved thanks to the production of 2 sectors of 170° + 1 sector of 20° for the VV instead of the original 14.

Additionally the following advantages are expected:

- Less welds in situ and then less distortions during torus closure (2 sectors of 170° + 1 sector of 20°)
- Responsibility of welds left to the VV supplier tested in factory
- Larger room for assembling magnetics
- Easier VV Thermal Shield assembly
- No need to store VV sectors while waiting for torus hall

Assembly schedule will require a specific assessment

#### **CfT July 2024**

# **Additional Heating Systems**



Up to **45 MW** of additional heating power to DTT by installation of :

### ECRH

- 16 MW first phase
- 32 MW third phase
- Gy. Joint proc. with F4E

ICRH

- 4 MW first phase
- 8 MW third phase
- Solid state transmitter

### NBI

- 10 MW 500 keV
- Foreseen in the second phase



# ECH System: pre-series Gyrotron manufacturing

- FwC signed on May 2022: 1+ 7 units (up to 16 units) ٠
- Specific Contract N.1 signed on 1 of Aug 2022 ٠
- Final DRM done on 21 Mar 2023 ٠
- Assembled of the pre-serie unit completed: May 2023 ٠
- FAT @Falcon Test Facility: Oct 2023 ٠
- Final Acceptance Certificate: Nov 2023 ٠



# ECH System: 3D printing of Prototype of M1 fixed mirror for launcher

- Designing of M1 by optimization of the cooling spirals (bulk CuCrZr version) and perform thermal-mechanical simulations were done
- M1 mirror definition, enlightened printable version, to test the manufacturability with a prototype in Additive Manufacturing (reduction of the total mass of ~50%)
- Necessary mirror treatments (release of stresses, surface treatments) will be continued in 2023



- <u>Material</u>: copper alloy CuCrZr
- AM technique: Laser Powder Bed Fusion machine used (DIAM lab, INFN-Pd)
- Goal: Manufacturing of complex geometries (mirror with internal cooling channels)

## Ion cyclotron resonance heating





# Schedule of the auxiliary heating CfT



### ECRH:

Gyrotron tender assigned: completion 2027

### HVPS + AUX for gyrotron:

Market Survey Jan. 2023

S-DRM Feb. 2023

Call for Tender: July 2023

#### TL Vacuum System:

C-DRM June 2023

E-DRM June 2024

S-DRM Dec. 24

Call for Tenders 2025

#### Launcher :

C-DRM June 2023

E-DRM June 2024

S-DRM Dec. 24

Call for Tenders 2025

### ICRH:

Solid State Transmitter (PNRR) Market Survey completed Call for. Tender May 2023 TL components: C-DRM Mar. 2023 S-DRM (Excl. Test Bed PNRR): Mar. 2024 Call for Tender Oct. 2023 (Test Bed PNRR) Call for Tender Aug. 2024 Antenna : C-DRM Apr. 2023 S-DRM Jan. 2025





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### Scientific programme



The activities for the preparation of the DTT Research Plan have been launched.

82 proposals for membership of the drafting group received from 15 European laboratories (non Italian participation 54%)

First version of the plan expected in June 2023 in time for the EUROfusion facility review



### International collaborations





# **Concluding remarks**



- ✓ DTT is progressing in the construction phase. Contracts for a total of 170M€ are ongoing. The CfT for the vacuum vessel is now ready to be launched. PF coils CfT will follow in summer 2023 and electrical distribution system and new buildings at the end of 2023.
- ✓ The preparation of the Research Plan has started with the involvment of EUROfusion laboratories
- ✓ DTT is a challenge and an opportunity. Its success requires a focus of the Italian human resources on the project, a prioritization of the effort in all the shareholders and a strong collaboration with industry.