Energy Fridays 12/05/2023

ENI - Magnetic Fusion Initiatives

Antonio Trotta

ENI IN BRIEF

ENI'S MISSION

We are an energy company.

We concretely support a just energy transition,

with the objective of preserving our planet

And promoting an efficient and sustainable Access to energy for all.

Our work is based on passion and innovation,

on our unique strength and skills,

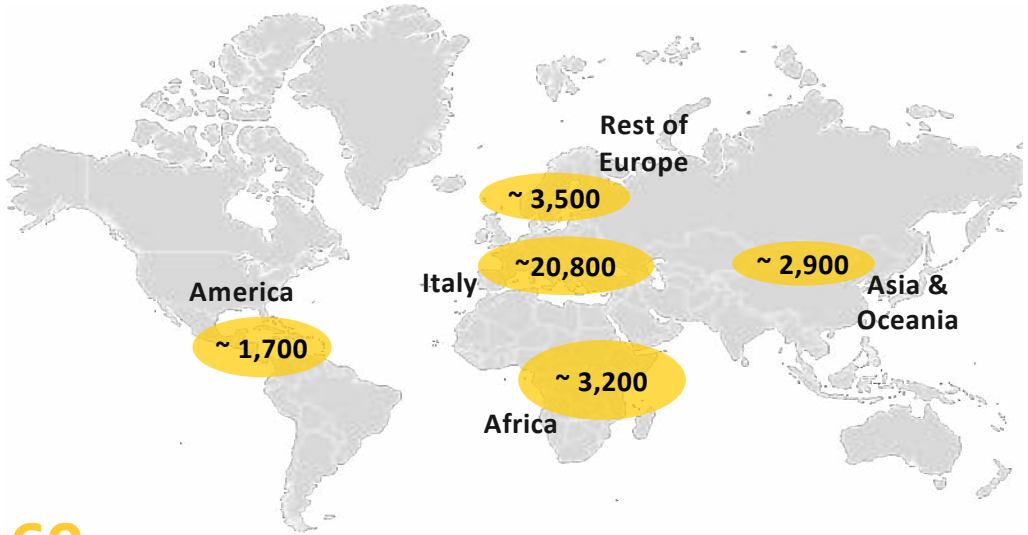
on the equal dignity of each person, recognising diversity as a key value for human development,

on the responsibility, integrity and transparency of our actions.

We believe in the value of long term partnerships with the countries and communities where we operate bringing long-lasting prosperity for all.

SUSTAINABLE DEVELOPMENT GOALS

ENI'S GLOBAL PRESENCE



69 COUNTRIES OF PRESENCE

32,000 ENI PEOPLE*

10,000 ENI PEOPLE ABROAD

85% AVERAGE PRESENCE OF LOCAL EMPLOYEES ABROAD

Figures at 31 December 2021

** Eni SpA & consolidated subsidiaries*

ENI'S ORGANIZATIONAL STRUCTURE

SUPPORT FUNCTIONS

TECHNOLOGY, R&D & DIGITAL

NATURAL RESOURCES

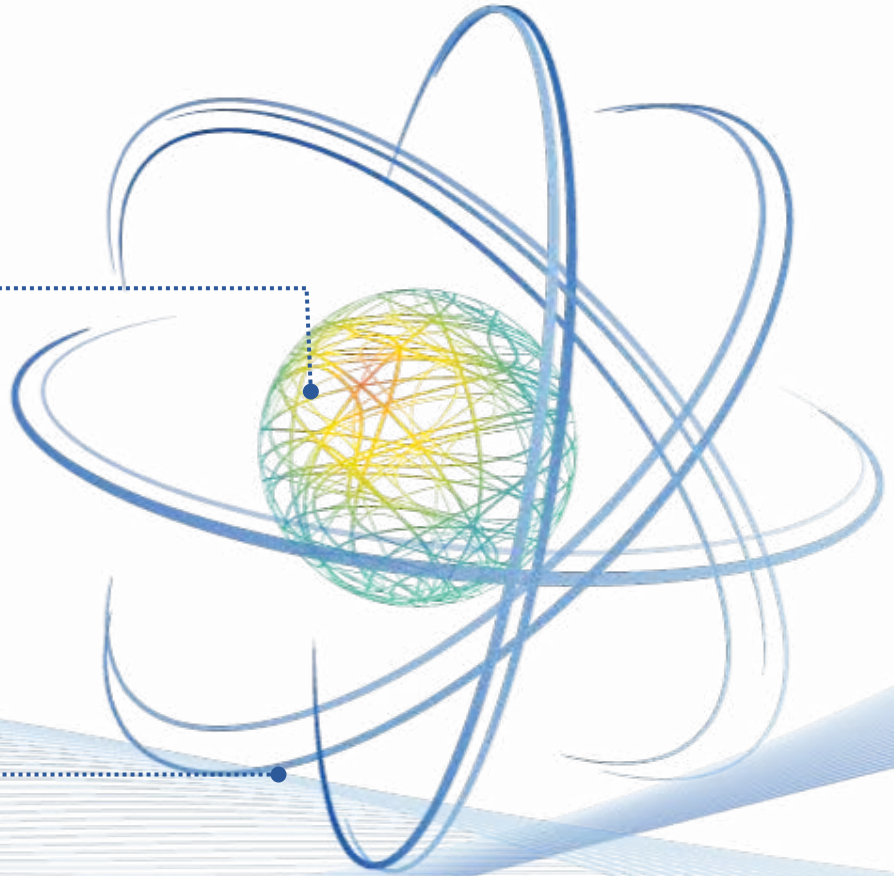
OIL, GAS, LNG, AGRI-FEEDSTOCK, CCUS, CARBON OFFSET

ENERGY EVOLUTION

TRADITIONAL TO BIO, BLUE, GREEN PRODUCTS

TO BE A LEADER IN THE ENERGY TRANSITION

ENI DISTINCTIVE APPROACH | Delivering value through the transition



PROPRIETARY AND BREAKTHROUGH TECHNOLOGIES

expanding a diversified portfolio of decarbonized products

LEADING EDGE
COMPETITIVE
BUILDING SCALE

STAKEHOLDER ALLIANCES

partnering and jointly contributing to an inclusive transition

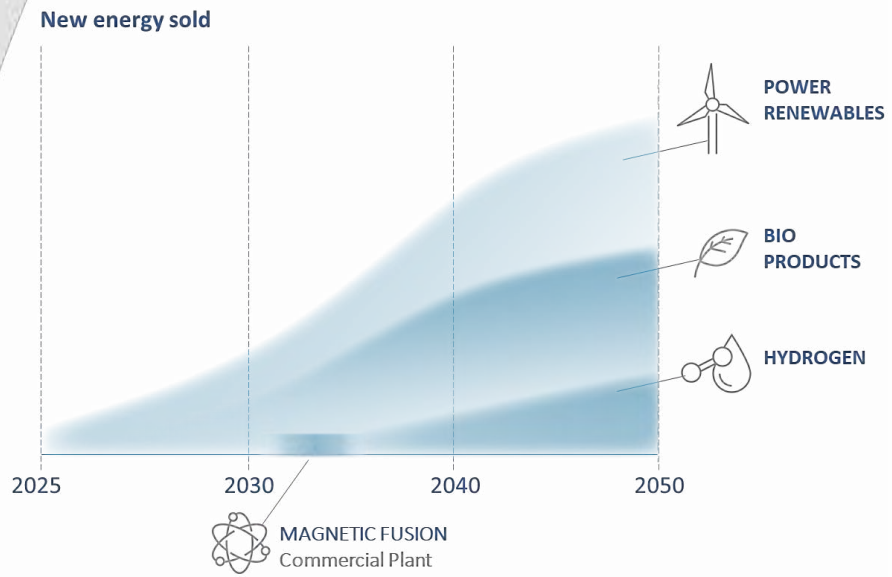
OUR PEOPLE
CUSTOMERS
INDUSTRIES
CITIZENS

NEW BUSINESS MODELS

matching business growth with dedicated leadership team and capital structure

LEANER & FIT
GROWTH &
VALUE-ORIENTED

ENI DECARBONIZATION STRATEGY: TOWARDS A NET ZERO ENERGY BUSINESS BY 2050



A COMPACT FUSION ENERGY POWER PLANT COMMERCIALLY EXPLOITABLE

< 15 years

Eni Commitment in De-carbonization

- Zero carbon emission by 2050
- Sustainable energy

Short & Mid-Term Strategy

- Renewable, bio-masses, bio-fuel, hydrogen, CCS (Carbon Capture & Storage), circular economy

Long Term Strategy

Magnetic confinement fusion

- Breakthrough technologies
- Risk management through validation of innovative technologies

BREAKTROUGH TECHNOLOGY FOR A CLEAN AND RELIABLE ENERGY

MFI organzation

DTT

Commonwealth Fusion Systems

MFI
Magnetic Fusion Initiatives

MAFID - Magnetic Fusion Industrial Development	MAFE – Magnetic Fusion Technologies Development	MFID – Magnetic Fusion Initiatives Development

ENI FUSION ACTIVITIES ALONG

TECHNOLOGY DEVELOPMENT

INDUSTRIAL DEVELOPMENT

BUSINESS DEVELOPMENT

Main Activities on innovative technologies :

- ✓ Tritium
- ✓ System Integration
- ✓ Power electronics
- ✓ Plasma Physics
- ✓ Molten Salts
- ✓ Magnets/Quench
- ✓ Materials
- ✓ Safety
- ✓ Diagnostics

Eni Team Directly Involved in:

- ✓ Development of Enabling & Innovative technologies
- ✓ Engineering and Construction
- ✓ Project Management, Procurement, Market aspects

Development of studies on:

- ✓ Fusion Energy Scenarios
- ✓ Fusion Supply Chain

Eni Fusion Program

- ✓ 50+ people engaged
- ✓ Aspects covered: CFS; DTT; technology Monitoring; Industrial development Models; Stakeholders; Communications; HSE; Supply Chain & Italian ecosystem

Engagement with 5+ Fusion Agencies & Associations

THE 3 PILLARS FOR FUSION ENERGY DEVELOPMENT IN ENI

1 CFS/MIT

Commonwealth Fusion Systems

From SPARC to ARC:

a path towards industrial application

MIT

Eni & MIT activated LIFT projects: R&D to accelerate and "de-risk" the path towards ARC

OBJECTIVE : ARC REALIZATION FOR POWER GENERATION ON A CONTINUOUS BASIS (Q>>1)

2 DTT

ENEA

Eni joined ENEA in the Limited Liability Cooperative DTT (Divertor Tokamak Test Facility) contributing to the project with its own project engineering skills for the development of a fusion plant

OBJECTIVE: CONSTRUCTION & OPERATION OF THE DTT TO MANAGE THERMAL LOAD

3 Joint Research Center Eni-CNR

CENTRO RICERCHE ENI - CNR Ettore Majorana

Eni created a JRC with CNR for:

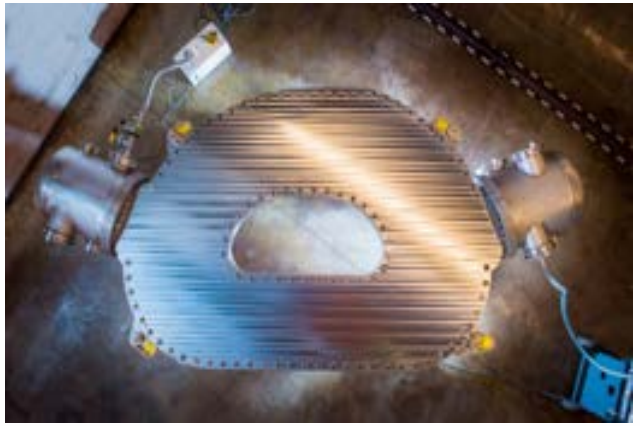
- Basic research
- Advanced Modeling
- Development of local skills through the activation of research and doctoral scholarships.

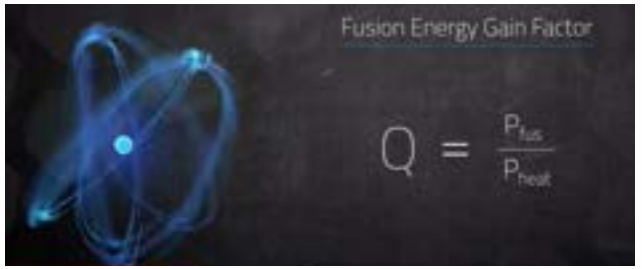
OBJECTIVE: DEVELOPMENT OF "KNOW HOW" ON FUSION ENERGY

ENI - CFS ROADMAP

ENI ENDORSED MIT APPROACH: INNOVATIVE TECHNOLOGIES - KNOWN PHYSICS

2018	**Eni investment in CFS → 3 phase fast-track approach to the first commercial compact high field tokamak**
2021	**Phase 1**: **20T HTS** magnetic field reached ✓
2025	**Phase 2**: **SPARC** First experimental tokamak for technology demonstration Q > 1
Early 30s	**Phase 3: ARC** first demonstration fusion power plant





ENI WAS THE FIRST MOVER IN THE ENERGY INDUSTRY

LIFT PROJECTS

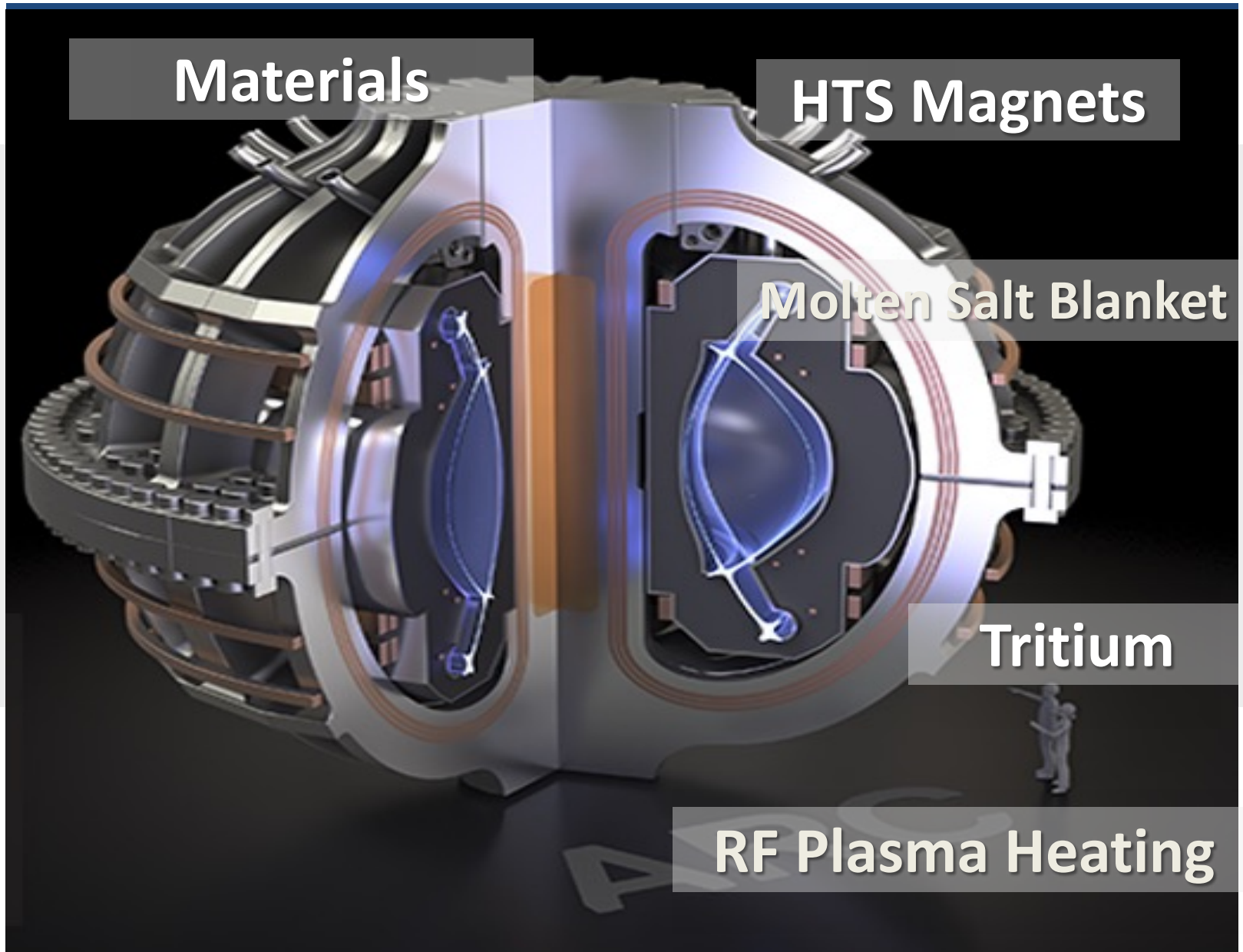
LIFT Program

L*aboratories for*

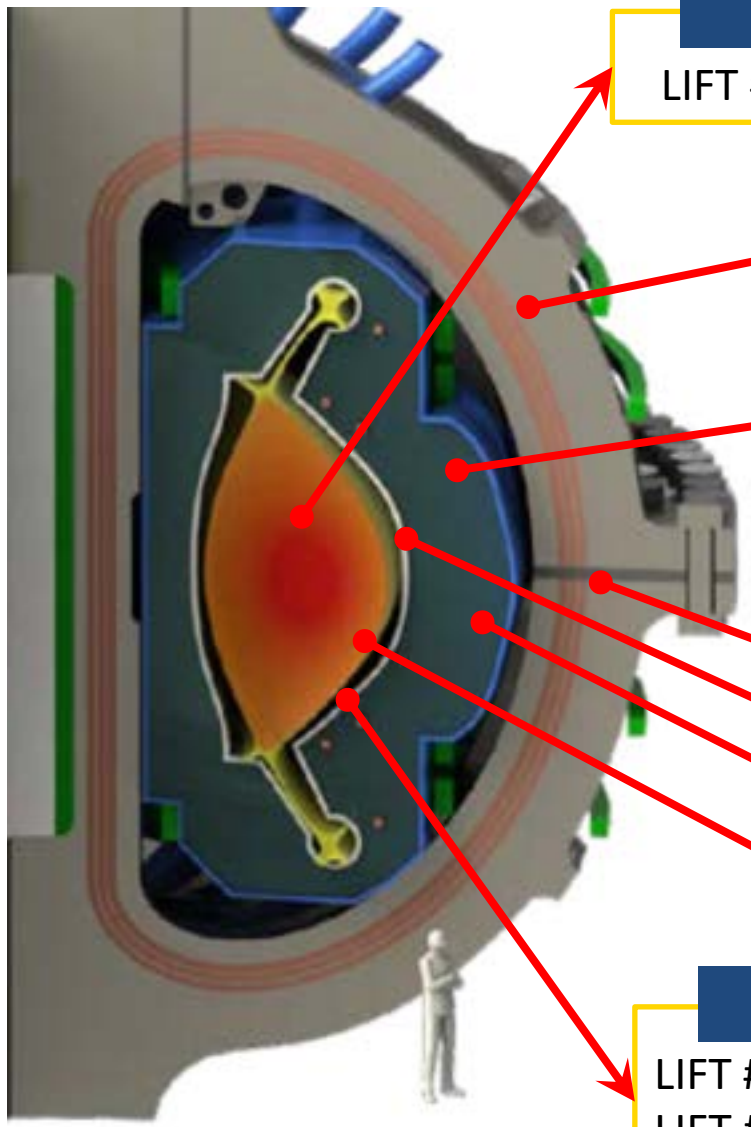
I*nnovation in*

F*usion*

T*echnology*



LIFT Projects for Accelerating the Development of ARC



Tritium Inventory

LIFT #10 - Separation of He from D-T

HTS Magnets

LIFT #1 - ReBCo radiation damage √
LIFT #12 - Cryogenic Irradiation of HTS
NEW LIFT – Mcubed Q4 22

Molten Salt Blanket

LIFT #4 - Molten salt fluid dynamics in high B field √
LIFT #5 - FLiBe blanket validation plan √
Support to LIBRA project

Physics

NEW Lift Disruption Q4 22
NEW Lift Divertor Modelling Q4 22

Materials for Fusion

LIFT #2 - Intermediate energy ions for material damage √
LIFT #7 - Nanocomposite structural materials
LIFT #8 – Molten Salt Radiation decelerated corrosion
LIFT #9 - Rapid ARC structural and first wall bulk material down-selection
NEW LIFT (cont. lift # 11-9-8-3-2) – Q1 23

Vacuum Vessel & FW

LIFT #3 - Ultra-thin liquid first wall surfaces √
LIFT #11 - Liquid Sandwich Vacuum Vessel

Lift #6: Advanced Radio Frequency

JRA Eni-CNR

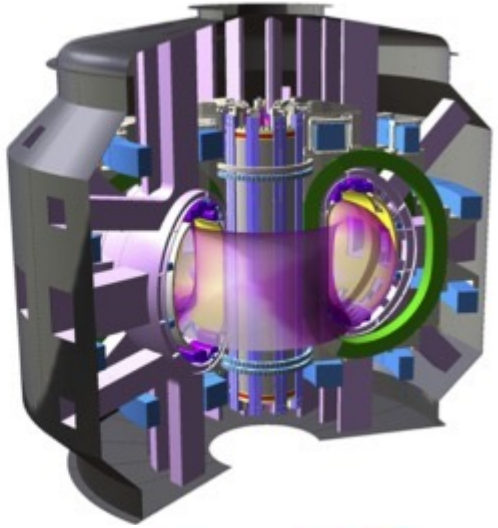

Line 1
Plasma Modelling
ISTP Milano
ISTP Padova
ISTP Bari
Line 2
Control Systems
ISTP Milano
IMM Catania
Line 3
Advanced Materials
ISTEC Faenza
IOM Trieste
INO Pisa
ISTP Milano
IPCF Messina
ISTP Milano
IOM Trieste
SPIN Genova
ISTP Padova
ISTEC Faenza
INO Pisa
ISTP Bari
IPCF Messina
JRC Gela
IMM Catania
Line 4
Superconductivity
SPIN Genova
IMM Catania
Line 5
Power Electronic
IMM Catania
ISTP Milano
Line 6
Diagnostic
ISTP Milano

DTT

Eni entered the DTT project in 2019 with a share of 25%.

Eni is involved in DTT by means of:

- internal resources directly seconded or assigned to the project
- engineering services throughout qualified suppliers
- R&D services provided throughout the major Italian universities (PoliMI, PoliTO, UniPD …) & excellence R&D centres (CNR).



ENI Main Activities in the DTT Project

PROJECT MANAGEMENT INCLUDING

- Legal & procurement (support)
- HSE, occupational safety & risk analysis, radiation protection
- QA & QC

INNOVATIVE TECHNOLOGIES DEVELOPMENT AND VALORIZATION

SYSTEM INTEGRATION INCLUDING

- Technical office responsibilities
- System requirements & Interface management
- Novelties management: identification & follow-up
- Site layout & permitting
- CODAS & PCS

DTT

ENI Main Activities in the DTT Project

TOKAMAK HALL (WBS TKM)

Toroidal Field (TF), Poloidal Field (PF) & Central Solenoid (CS) magnets

- Design & engineering activities (support)
- Technical documentation for tenders
- Follow-up of suppliers

TF & PF magnets power supply

- Design & engineering activities (support)
- Technical documentation for tenders
- Follow-up of suppliers

Internal Vessel Coils (IVC) power supply

- Design & engineering activities up to tender documentation (support)
- Follow-up of suppliers

Remote Handling System (RHS) for In-Vessel components

- Responsibility of design & engineering activities
- Design & engineering activities including kinematic models, reachability analysis, interface with other subsystems …

HEATING & CURRENT DRIVE (WBS HCD)

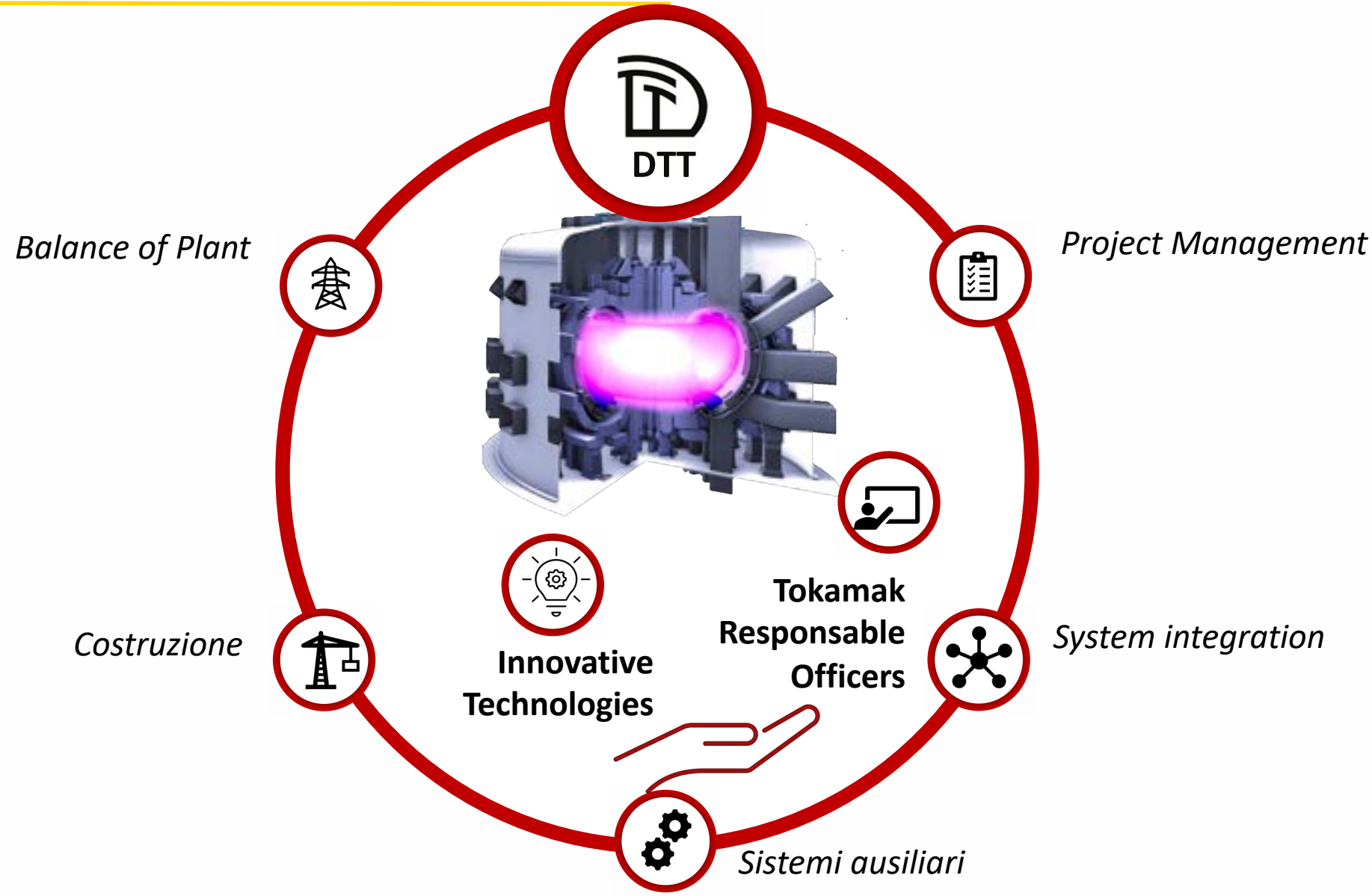
ECH launcher & control system (support)

ICH transmitter & control system (support)

BALANCE OF PLANTS (WBS BOP)

- New BUIldings (BUI)
- Refurbishment & revamping of existing BUI
- AUXiliary plant project (AUX)
- Electrical Distribution System (EDS)
- Control Safety Security Telecom Systems (AUT)

DTT Secondees & MAFID People dedicated to the project



We are coming…

THANKS – Q&A SESSION

antonio.trotta@eni.com

Images and video are courtesy of CFS/MIT/DTT and JET