Overview of physics and technology of magnetic fusion in Italy
PHYSICS

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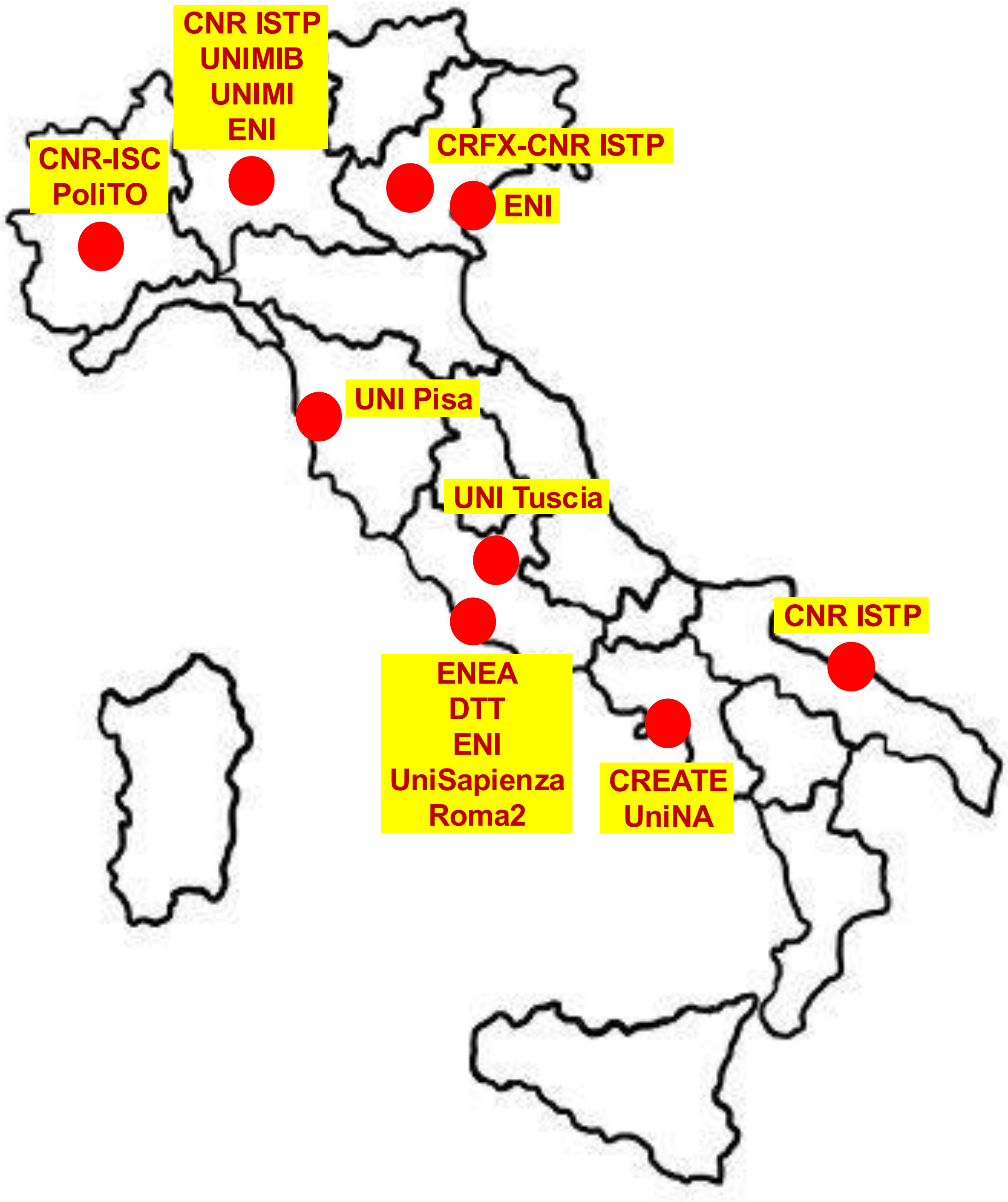
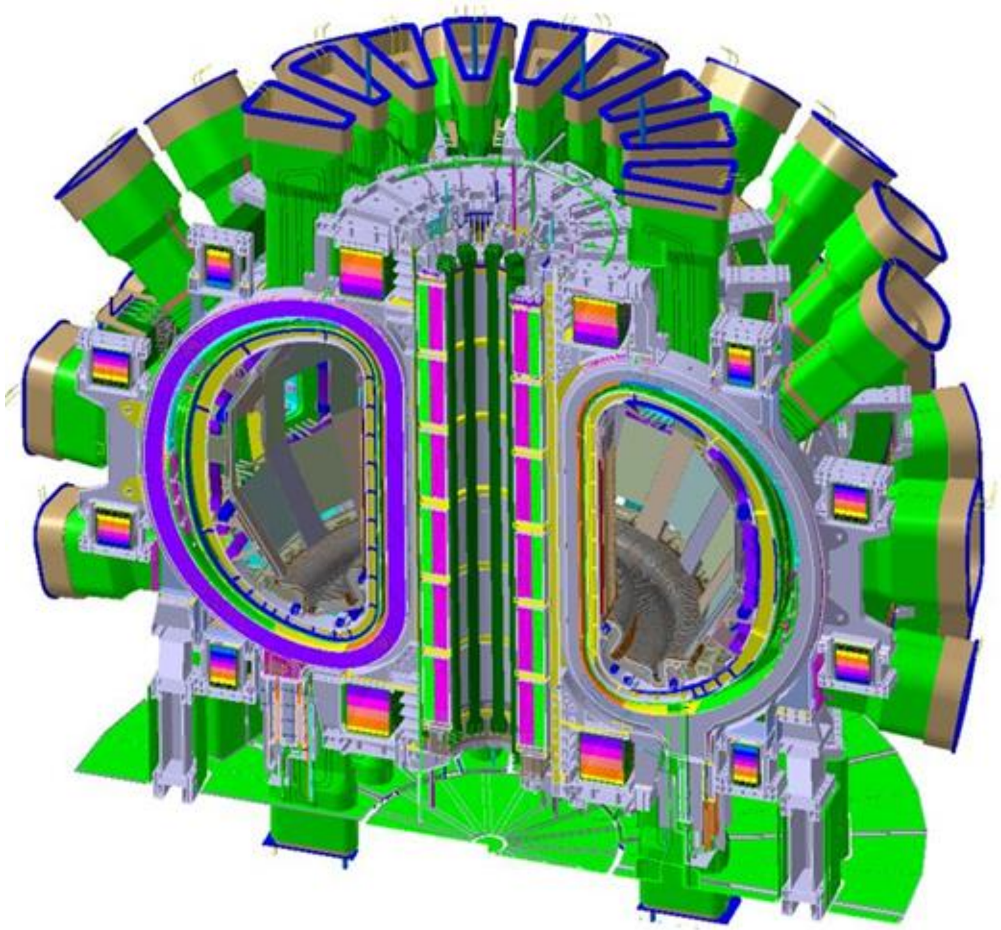
Conferenza Italiana Plasmi, ENEA Frascati, 3-6 Febbraio 2026

Plasma in Italy



DTT, a national enterprise



ENEA ITALIAN NATIONAL AGENCY FOR NEW TECHNOLOGIES, ENERGY AND SUSTAINABLE ECONOMIC DEVELOPMENT · CETMA · Consiglio Nazionale delle Ricerche · Create · CONSORZIO RFX Ricerca Formazione Innovazione · eni · INFN · Politecnico di Torino · Università degli Studi di Milano Bicocca · Università di Roma Tor Vergata · Università degli Studi della Tuscia

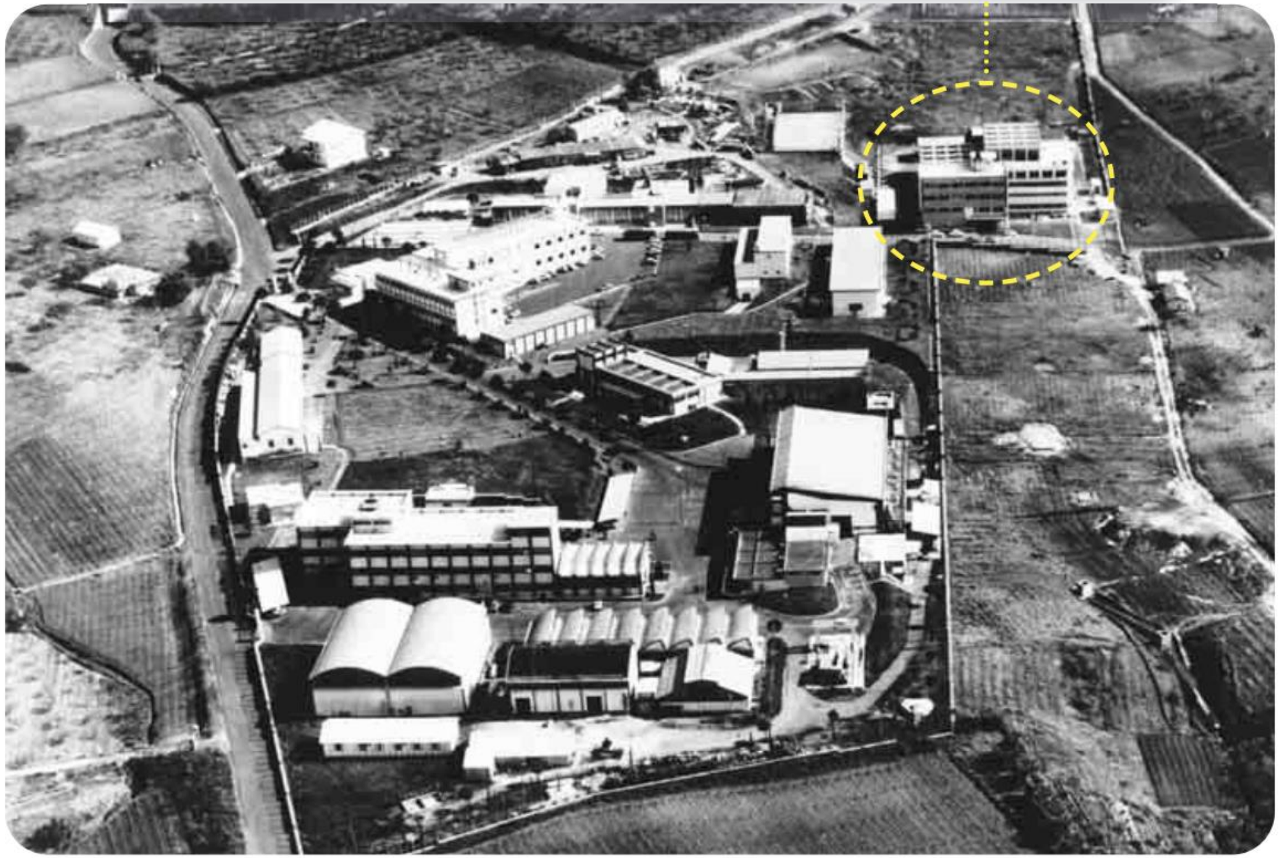
Italy, plasma and fusion: a long history

1960 – 2010

50

anni di ricerca sulla fusione in Italia

years of fusion research in Italy



How input has been requested

- List of the main activities
- Key activity/result
- List of present or planned contributions to DTT
- Key contribution to DTT
- Outlook for 2026 and beyond

ENEA Frascati experimental activity

MCF Diagnostics

- VuV spectrometer JT-60SA
- Runaway electron diagnostics, experiments and modeling (WEST, JT-60SA)
- Neutron diagnostics design for tokamaks (ITER, DTT)
- Radiation-hard neutron detector design/characterization
- Development of innovative fiber-based neutron and gamma detectors (FNG)
- DT gamma measurements (FNG)
- N-17 neutron measurements from water activation in KATANA facility at JSI with Li glass
- GEM detectors for X-ray imaging in KSTAR

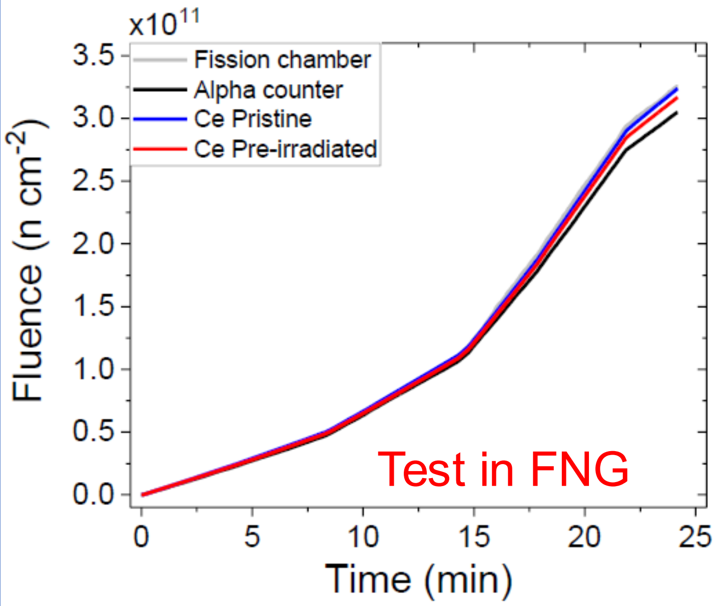
Participation as SL to machine operation (e.g. WEST) and JT-60SA commissioning

Plasma-wall interaction studies

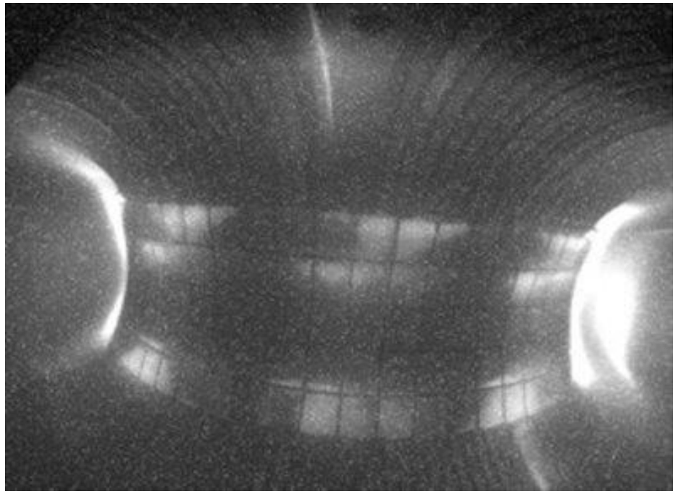
- material charaterization using TDS, LIBS, LID-QMS
- CCG cold catode gauge optimization for JT-60SA

ENEA Frascati experimental activity: examples

Fiber-based neutron and gamma detectors in fusion environment



L. Weninger et al. Results in Optics, 2025,
M. Roche et al. IEEE TNS,2025



Runaway Electron Imaging Spectrometry (REIS)

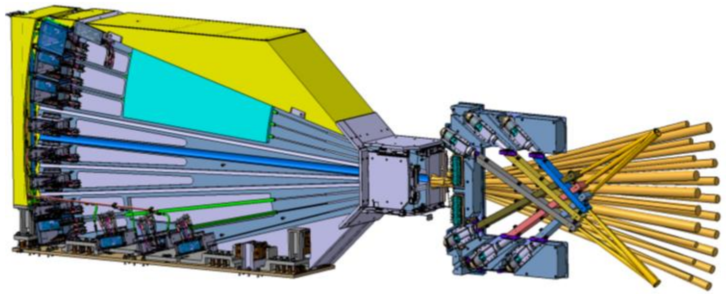
Portable and multi-device diagnostic installed and operated in FTU, AUG, COMPASS, TCV and WEST (2023-2025)

[G Ghillardi et al., Plasma Phys. Control. Fusion 67 (2025) 055029]

ITER Radial Neutron Camera (RNC) 22 lines of sight

Design completed by European Consortium led by ENEA-Frascati (Final Design Review July 2025)

Development of RNC digital twin on-going in ITER Integrated Modelling & Analysis Suite (IMAS)



[B. Esposito et al., Journal of Fusion Energy 41 (2022) 22

ENEA Frascati: Theory, Simulation and Validation

- Leading research group pioneering the study of burning plasmas physics (first-principles phase space transport theory)
- Development of the Divertor Tokamak Test (DTT) and the BEST Research Plans, defining the strategy for burning-plasma studies in next generation experiments
- Joint conceptualization and development with IPP of ATEP, the first code dedicated to simulating phase space transport in fusion plasmas
- Verification and Validation within ITER activities: development of phase-space diagnostics for Gyrokinetics and new tools enabling simulations on transport time scales
- Reference hub for the Center for Nonlinear Plasma Science (CNPS) activities – Europe, PRC, Korea, US
  - focused but not limited to burning plasmas
- **Cross-fertilization between Fusion and Space plasmas: earth magnetosphere and MARS**

Falessi et al. 2026 TBS; Lauber, Falessi, Zonca et al NF 2025
Teng, Zonca, Chen, Tao, Nat. Comm. (2023)
Zonca et al. ICPP 2024 Seoul

The crucial role of meso-scales and non-Maxwellian distribution functions in plasma self-organization have been demonstrated

NSFC-MAECI (China Italy) project on the interaction between Turbulence and Energetic Particles

ENEA Frascati present or planned contributions to DTT

Development of DTT diagnostics

- Diagnostic divided in five categories -> Magnetics Measurements (DMM); Wall Interaction Measurements (DWI); Scattering Techniques and Radiation-Spectroscopic Measurements (DIR); Interferometric and Microwave Techniques (DIM); Neutrons, Gammas, Run-Aways and Fast Particles Measurements (DNF)
- Activities mainly focused on procurement, but R&D considered as well
- Setting up of the laboratories and manpower for the diagnostic installation and operation

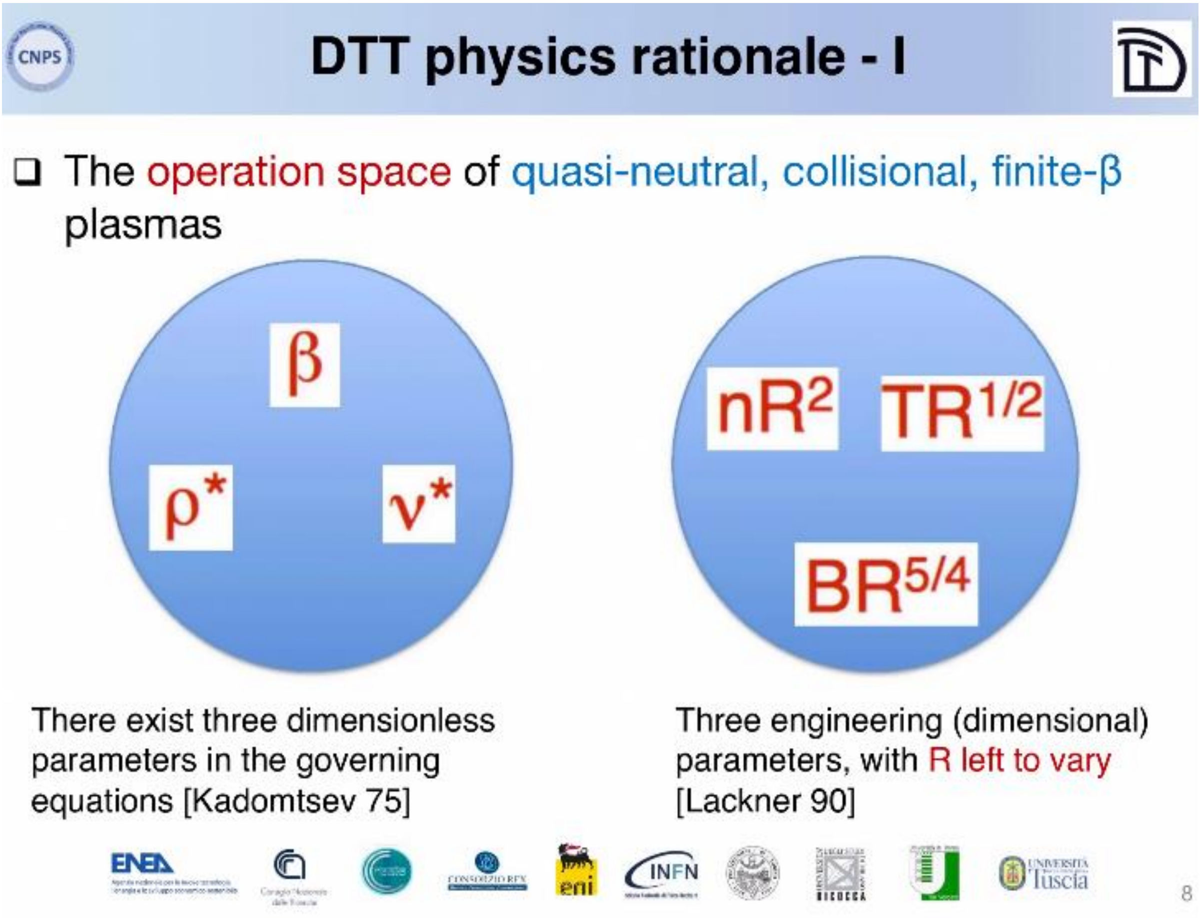
Preparation of the DTT Operation

- Discussion about key aspect of the commissioning phase: the formation of an expert team to coordinate commissioning activities
- Setting up duties and working space for the Commission Team

ENEA Frascati: present or planned contributions to DTT

ENEA DTT Research Plan contribution

- The theory group in Frascati contributed fundamentally to the DTT conceptualization
- The weakly similarity scaling has been derived and applied for an initial design of DTT scenarios
- The scaling and its implication for similarity experiments are described within the Research plan
- Particular focus to studies for Burning plasma physics: integrated transport, MHD and EP;
- Theory, MHD and EPs Responsible officers are from the theory group



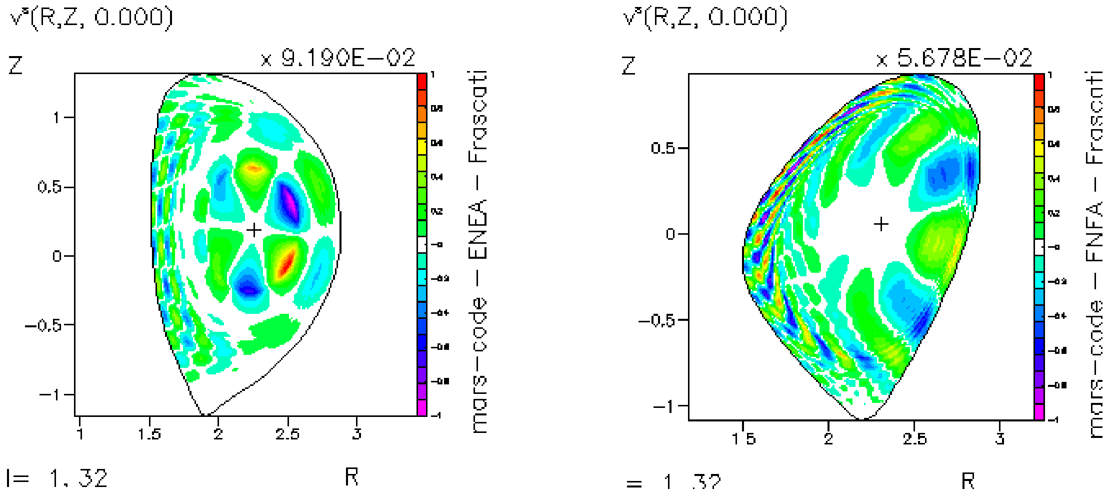
[Zonca et al. ICPP 2024 Seoul]

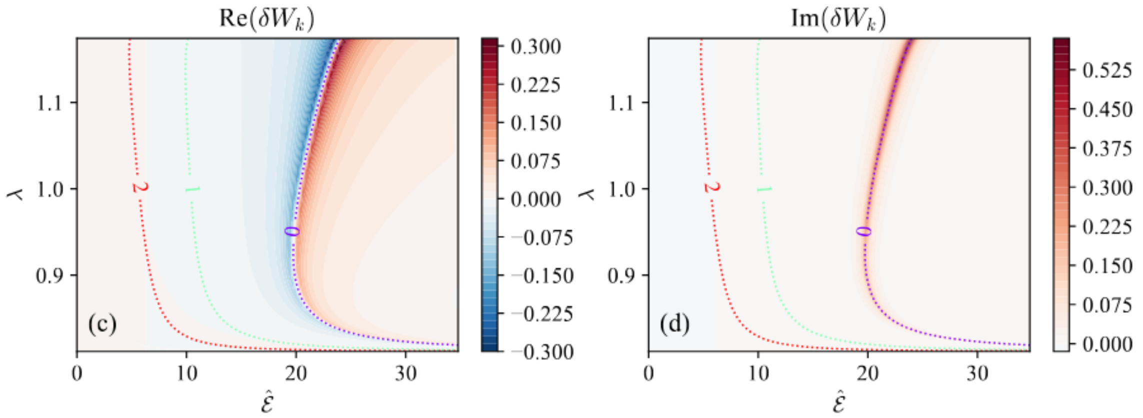
ENEA Frascati: present or planned contributions to DTT

- MHD stability in positive and negative triangularity has been characterized: internal kink, infernal modes and global Alfvén eigenmodes [Fusco, Vlad et al]

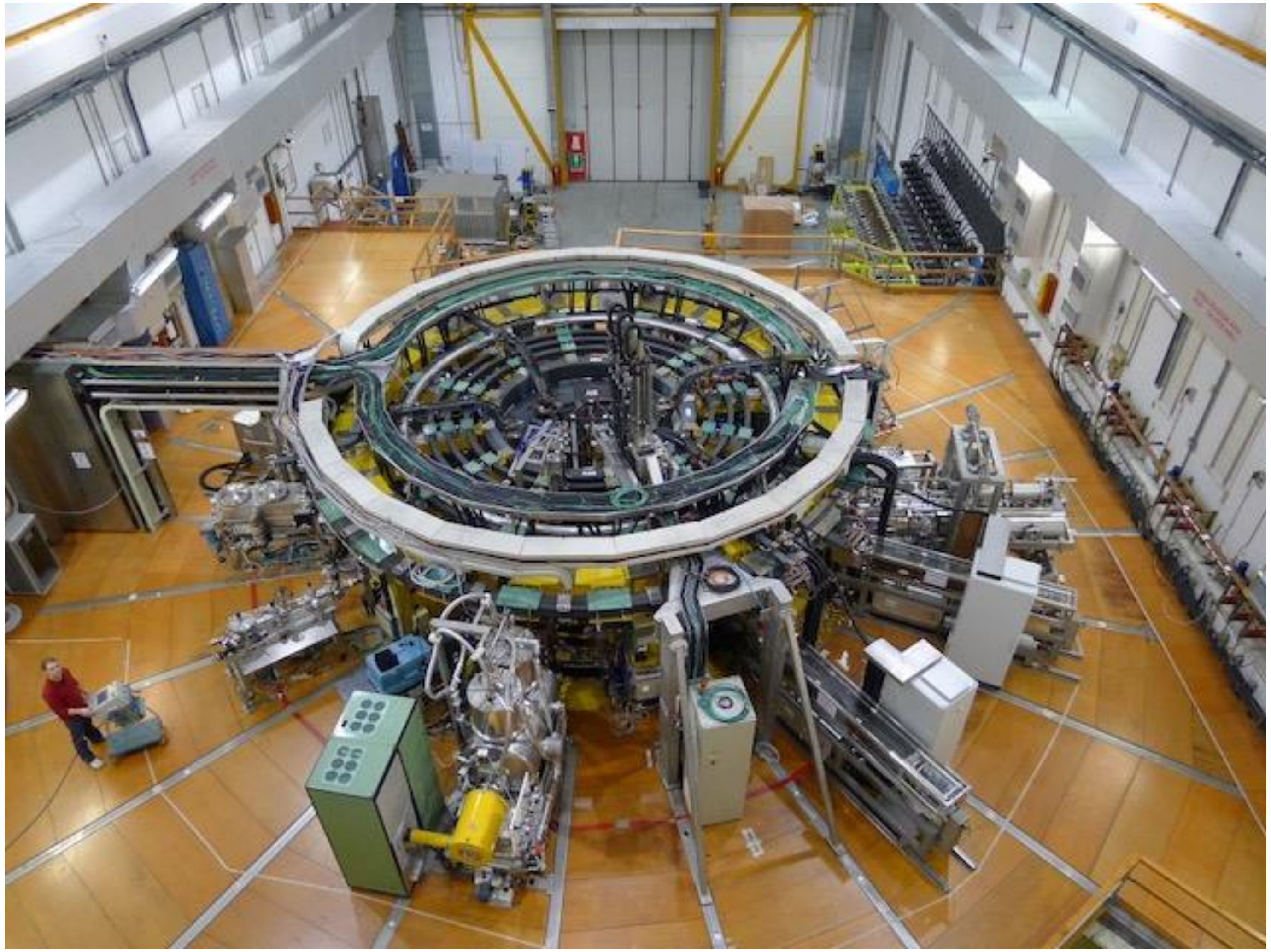
- Energetic Particles modes driven by the NNBI and ICRH fast particles have been studied using GK simulations: [G. Wei, Zonca, Falessi, Fusco, Qiu Submitted to PoP 2026], [Vlad, Fusco et al 2026]
- Performance optimization in terms of magnetic geometry and distribution functions is undergoing

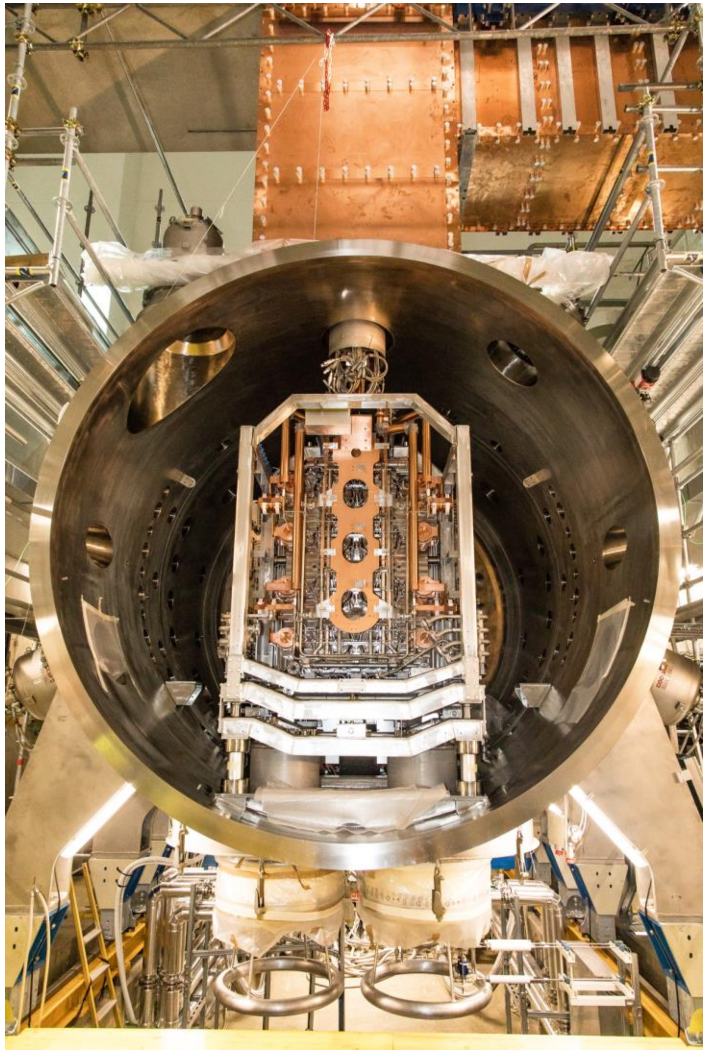
Toroidal Alfvén Eigenmodes





Consorzio RFX Padova: RFX & NBTF





RFX-mod2 main activities

RFX-mod2, upgraded version of RFX-mod, medium size toroidal device (R/a=2/0.5m) with unique MHD feedback control system and plasma magnetic confinement configuration versatility

Configuration	Ip (MA)	B_ϕ (T)	$q_{edge} = a/R \cdot B_\phi/B_\theta$
Reversed-Field Pinch	2	1.7 (on-axis self-generated)	< 0
Tokamak	0.2	0.55	> 2
Ultra-low q	1	0.55	< 1

RFX-mod2 listed as high priority strategic infrastructure within the PNIR (Italian Program of Research Infrastructures 2021-2027)

- **Experimental RFP physics (***with improved boundary in RFX-mod2 and NEFERTARI diagnostics***)**
- **Experimental tokamak physics** *(ohmic, 0.5T, electrode induced H-mode, shaped also with Neg. Triang)*
- **Experimental Real-time MHD control** *(Marte2 based)*
- **Advanced diagnostic systems development**
  - **Core:** 1kHz Thomson Scattering, SXR Double filter tomography, bolometry, NPA & DNBI Ti and flow, SXR GEM and neutrons
  - **Edge:** 2D Narrow-band Imaging of PWI, Light Impurities 2D tomography, Reflectometry, electrostatic probes arrays
- **Fusion Fission Hybrid RFP reactor studies**

RFX-mod2: the NEFERTARI Project

New Equipment for Fusion Experimental Research and Technological Advancement with Rfx Infrastructure

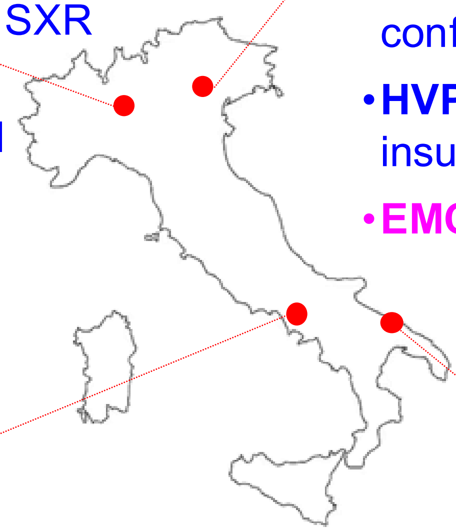
ISTP BA-MI-PD, UniNA, UniPD 2022-2026 18M€

CNR ISTP (Mi)

- **NeutronXLab** (development of neutronic and SXR diagnostics)
- **BiGym** (Linear Plasma Machine– plasma wall interaction)

CNR ISTP (Pd); Consorzio RFX, UNIPD – CRF

- **RFX-mod2** (toroidal machine for RFP & TOKAMAK confinement study)
- **HVPTF** (High Voltage Padova Test Facility – vacuum and gas insulation study)
- **EMCL** (Electro-Magnetic Compatibility Laboratory)



UNINA (DII, DIETI)

- **FARHA-ONE** (FAcility for Remote HAndling)
- MHD control simulation lab

CNR ISTP (Ba)

- **LaserDiLab** (development of optical diagnostics)

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Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
Consiglio Nazionale delle Ricerche

Nefertari

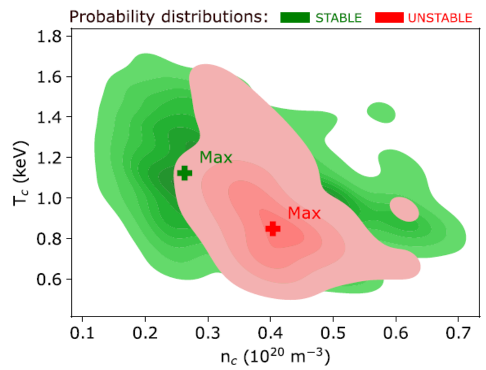
https://www.istp.cnr.it/nefertari/

Consorzio RFX

EUROfusion, F4E, ITER

- Magnetic confinement scenario: integrated modelling and exp. development
- MHD stability and active control techniques: modelling and experiment
- Core Transport physics
- Pedestal, Edge and Scrape-off layer physics
- Energetic Particle physics
- Disruption prediction, avoidance & mitigation
- Diagnostics development and operation

Identification of recurrent paths which lead to LM onset in MAST-U
2 Machine Learning models have been successfully trained and tested



Empirical probability distributions for core density (n_c) and core electron temperature (Tc) for the two classes, stable plasmas (green) and unstable plasmas (red). Distributions are shown as 2D contours on the (nc,Tc) plane.

M. Gambrioli et al., Plasma Phys and Cont Fus, 67 (2025) 045007

Theory and Advanced simulation

SpeCyl, PIXIE3D, JOREK (RFP & TOKAMAK)

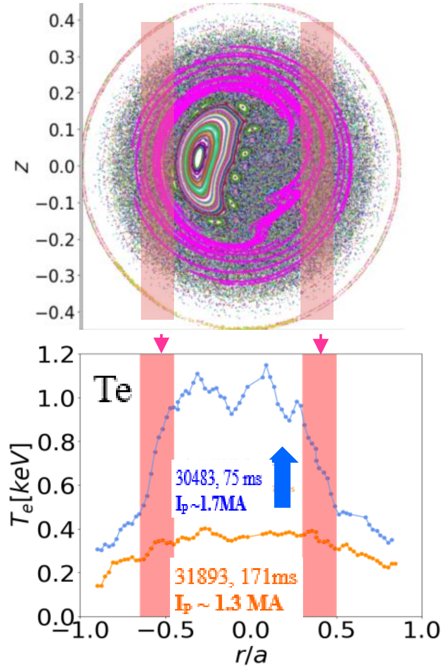
- 3D nonlinear MHD: Helical Self-Organization and Transients, Sawtoothing regimes
- 3D Reconnection Processes
- Boundary Conditions upgrade for better validation vs RFX mode control
- Magnetic chaos healing and structures in RFP (Lagrangian Coherent Structures)
- Wave – particle energy transfer (ion heating in RFP at reconnection events)

nonlinear code GBS (RFP & TOKAMAK)

- Drift-reduced boundary turbulence simulations (tokamak and RFP)

nonlinear code GENE

- Gyrokinetic modelling of turbulence in H-mode tokamak plasmas
  (isotope effect and role of impurity seeding in the pedestal)



Consorzio RFX: present or planned contributions to DTT

Present Contributions to DTT

- Magnetic diagnostic development
- Wall Conditioning via fixed GDC electrodes
- Non-Magnetic Plasma Diagnostics: Reflectometry for real-time position control
- Beam-plasma interaction studies

Planned contributions to DTT

- Human Capital & Training
- Hands-on Operational Training: control-room experience for PhD students and early-career researchers

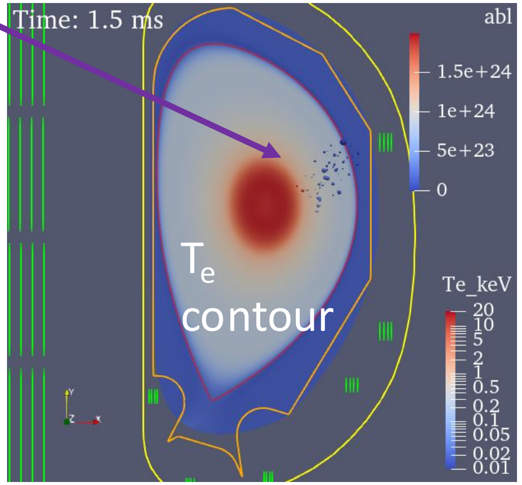
RFX present or planned contributions to DTT

3D nonlinear MHD advanced Simulation activities (JOREK code):

- Resonant Magnetic Perturbation technique for **Edge Localized Modes control**
- **Shattered Pellet** / Massive Gas Injection techniques for **disruption mitigation** and **Runaway electrons** simulations (Consorzio RFX, PoliTo, ISC-CNR)

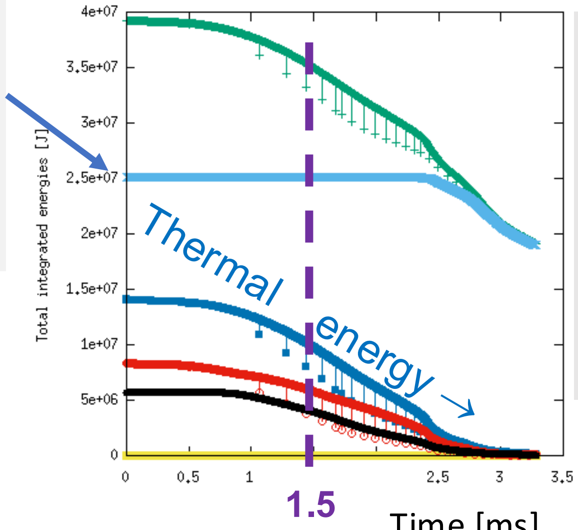
Preliminary axisymmetric SPI simulation for full power scenario:

SPI fragments cool down the plasma along their path



Time: 1.5 ms

… until most of **thermal energy** is radiated in a few ms

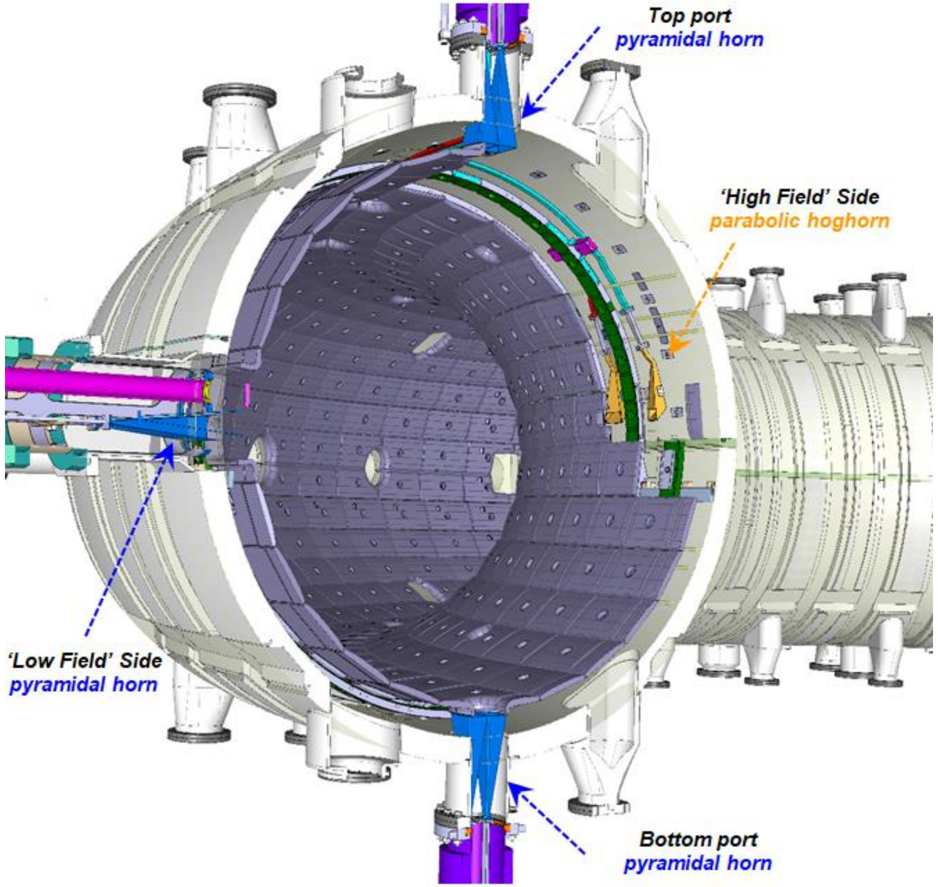


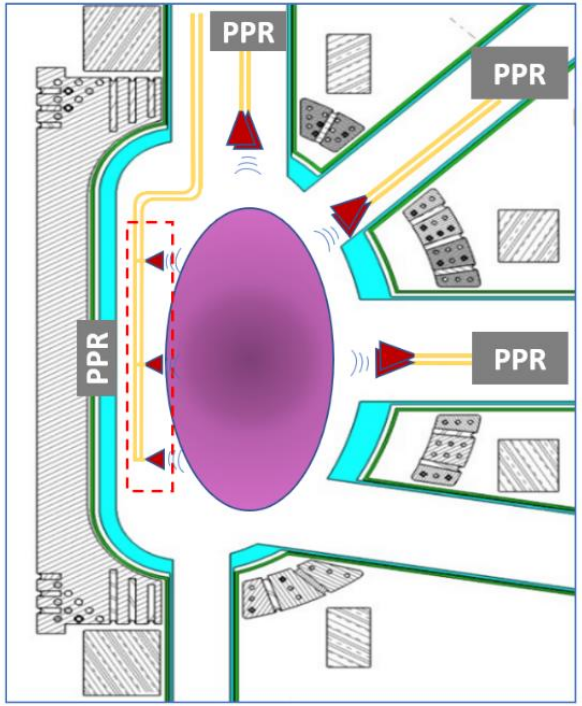
Energies:
Total
Magnetic
Thermal (total)
- Electron
- Ion
Kinetic

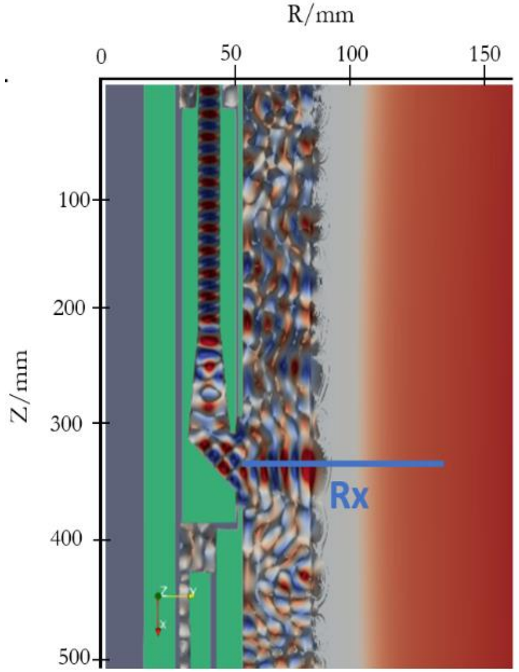
RFX present or planned contributions to DTT

- Integrated scenario modelling using first principle models (JINTRAC and ASTRA codes)
- Energetic particle distribution functions in DTT, NBI-ICRH synergy, NBI shinethrough
- Energetic particle losses in the presence of fluctuations, study of ripple-precession resonances
- Impact of 3D fields on EP confinement
- Magnetic Configurations and Control (WBS3 coordination)
  - ELM control study in DTT scenarios
  - EF correction optimization including plasma response models
  - runaway electrons control
- Disruption Control and Mitigation (WBS3 coordination)

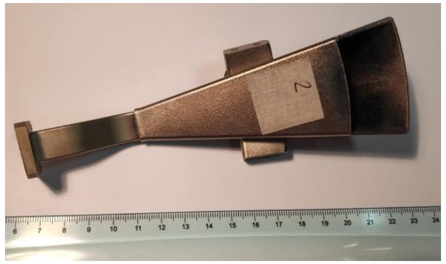
RFX-mod2 test bed for Plasma Position Reflectometry Control, also planned for DTT in view of DEMO







Simulated electric field of the midplane bistatic antenna in the DTT HFS



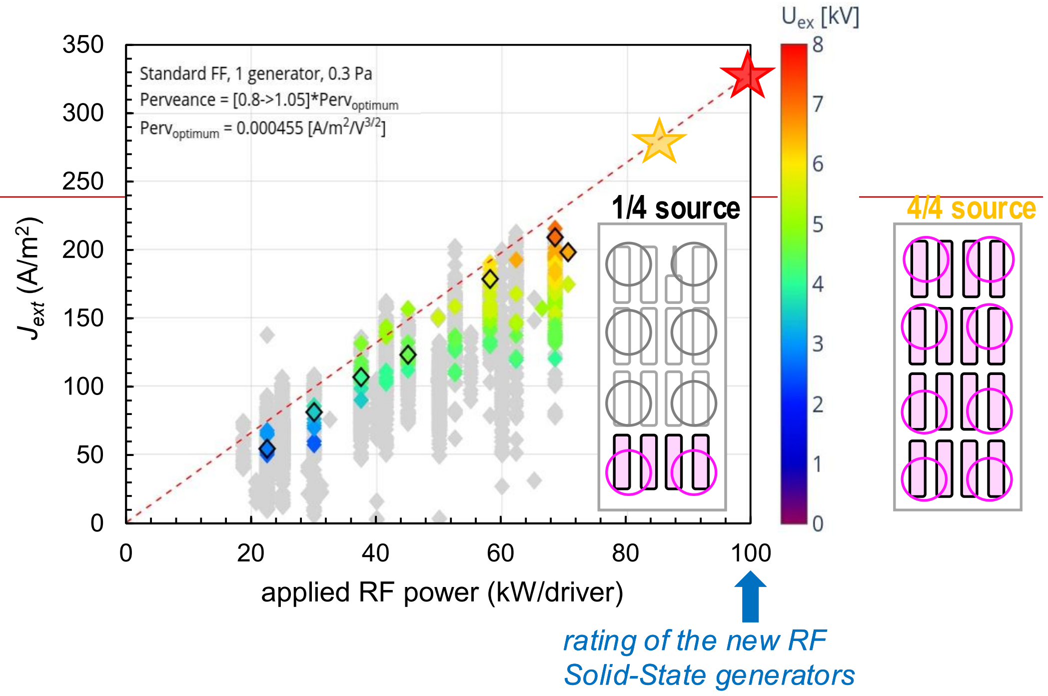
- **4 couples of RF antennas**
- **in-vessel** (between shell and vessel)
  - tight geometrical constraints

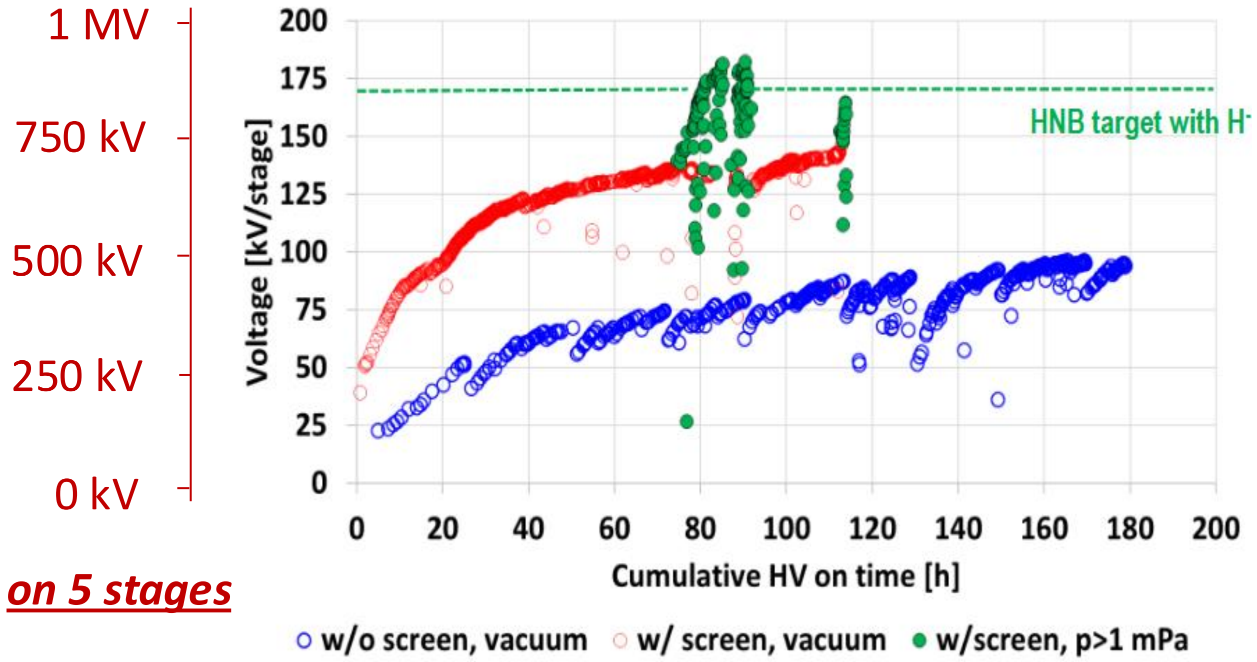
Ruffini Jinst 2025
10.1088/1748-0221/20/05/C05030

NBTF (dedicated talk by Pimazzoni)

At the NBTF, **SPIDER** is running:

- First campaigns of SPIDER **confirmed expected scaling of beam current density** with RF power
- Start operation with new RF generators and getter pumping system: **increasing beam current** and its homogeneity





and **MITICA** is on its way:

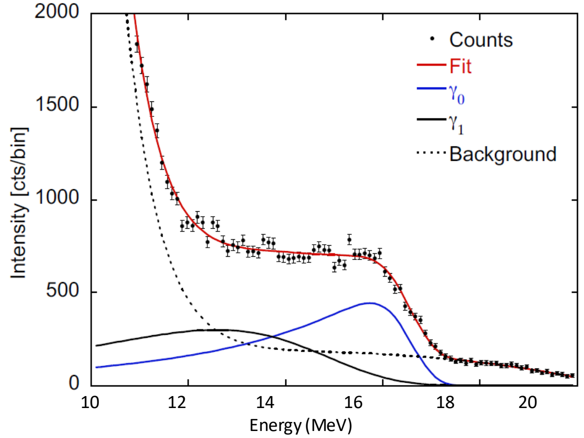
- HV holding @ MITICA was tested with a mock-up of the ion source: **ITER-grade beam energies are attainable!**
- Assembly and installation ongoing
- Beam operation expected in 2027

ISTP Milan main activities

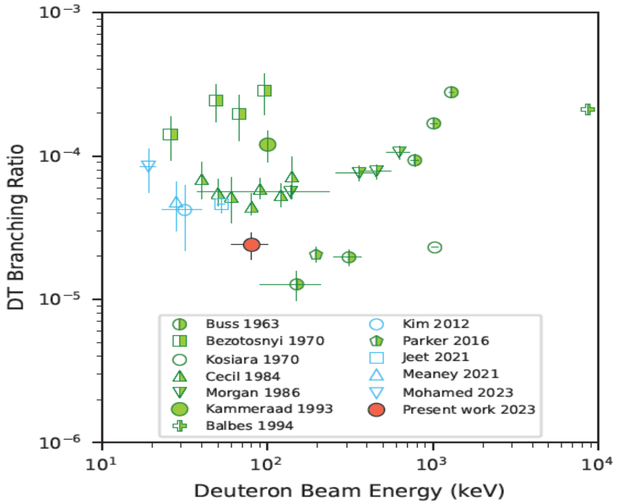
- Design and R&D development of the **DTT and DEMO ECRH** launchers and transmission lines
- Procurement of gyrotron, power supplies and RF loads for the DTT ECRH system
- Development of alternative **diagnostics for ITER fusion power measurement** using gamma-ray detection from $T(D,\gamma)^5He$. Development of neutron diagnostics.
- **Integrated transport modelling of DTT scenarios and of JET, AUG, TCV discharges** with impurity seeding or negative triangularity. Gyrokinetic simulations of turbulent transport in JET, TCV and DTT
- **Studies of MHD instabilities and their control**. Physics and control or mitigation of plasma disruptions.
- Application of ECRH/ECCD to plasma breakdown and operations
- **Design of DTT divertor and first wall**. Edge physics with with SOLEDGE and SOLPS-ITER codes
- Studies of impact of neutral gas dynamics on the retention, recycling, and release processes of fuel and impurity species by using Residual gas Analysis (RGA) and Optical gas Analysis (OGA)
- Developpment of **laser based diagnostic for in situ quantification of the fuel retained** on the surface of the wall
- Development of **DUSTTRACK** code to study the **transport of the W dust**
- Study of plasma–wall interaction properties (erosion, morphological changes, and fuel retention) of fusion-relevant materials (e.g., tungsten and boron), including sample production, plasma exposure in the **GyM linear device** and its upgraded version BiGyM, and post-exposure characterization using microscopy and surface analysis techniques

ISTP Milan: Development of nuclear diagnostics

Development of a second independent method to measure DT fusion power based on gamma rays

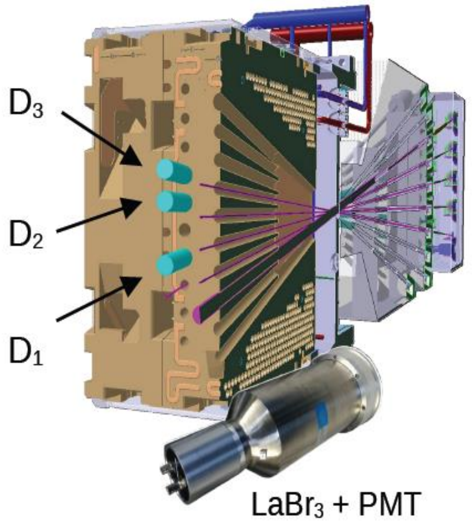


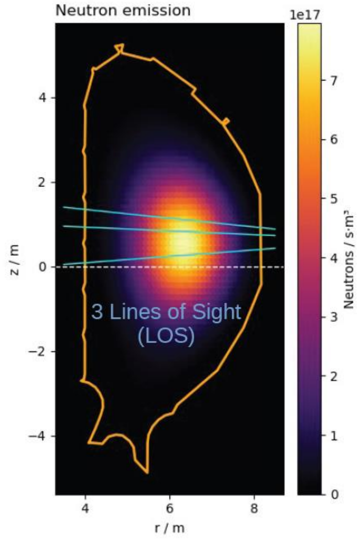
A. Dal Molin et al, Phys. Rev. Lett. ***133****, 055102 (2024)*
M. Rebai et al, Phys. Rev. C ***110****, 014625 (2024)*



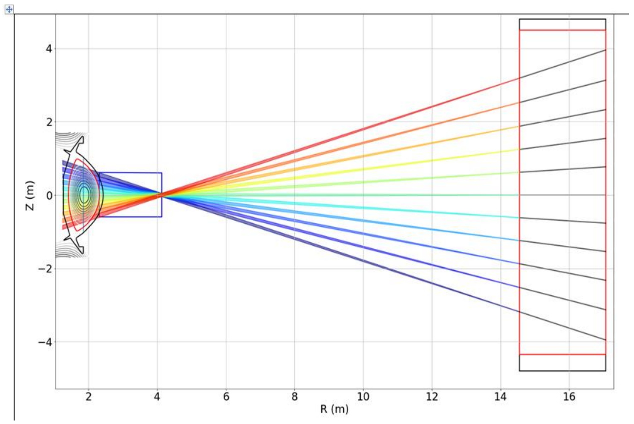
Design of neutron and gamma ray systems for tokamaks

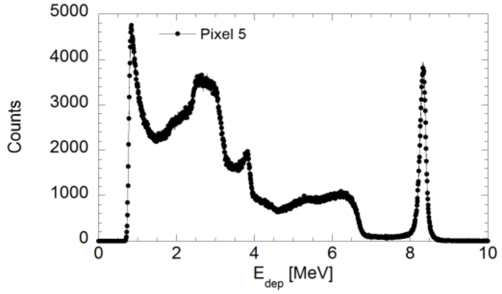
Radial Gamma Ray Spectrometer (RGRS) @ ITER





Neutron Camera (NCAM) @SPARC

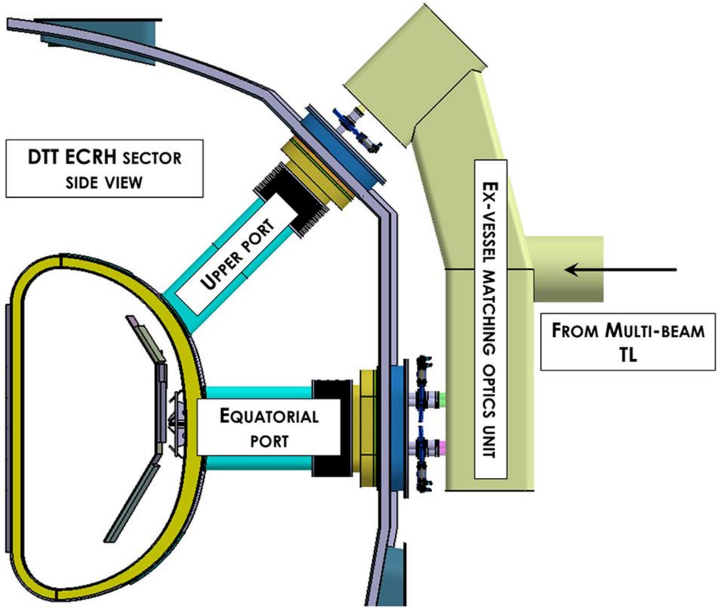




14 MeV spectroscopic **neutron camera for Ti profile measurements**

ISTP Milan: present or planned contributions to DTT

- Integrated design and R&D development of the DTT ECRH launcher and transmission line. ECRH physics studies.
- Procurement of gyrotron, power supplies and RF loads for the DTT ECRH system
- Study of DTT MHD instabilities and their control
- Integrated modelling of all DTT scenarios and creation of an IMAS database
- Gyrokinetic studies of DTT plasmas
- DTT break-down studies
- Power exhaust and divertor/first wall optimization
- Vacuum pumping and gas injections system
- Disruption mitigation by Massive Gas Injection
- Pellet injection for fuelling/ELM pacing and disruption mitigation
- ECE diagnostic
- Neutron and gamma-rays diagnostics; soft X-rays camera based on GEM



Key contribution to DTT: Integrated scenario modelling

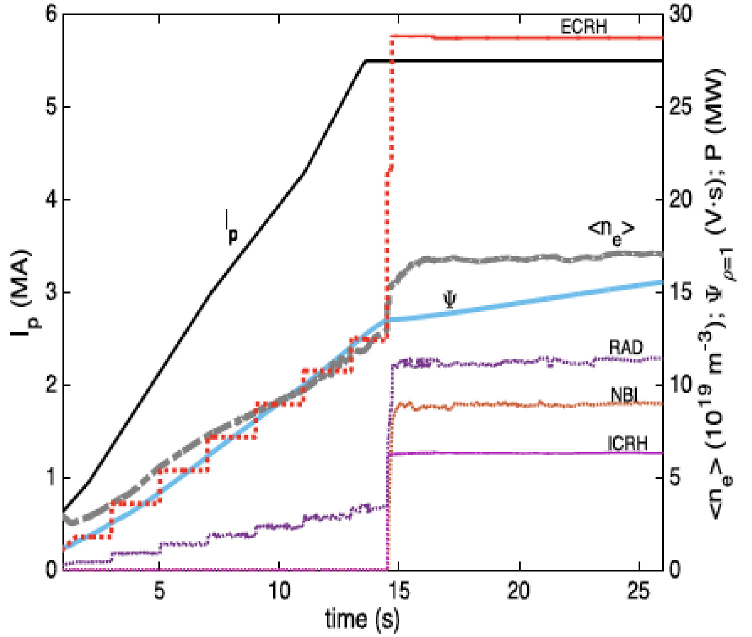
Integrated modelling of DTT scenarios has been key for the design optimization:

- finalization of machine size
- choice of heating mix and fuelling
- choice of Central Solenoid
- nuclear shield assessment
- diagnostic design.

It has also been the starting point for the elaboration of the DTT Research Plan.

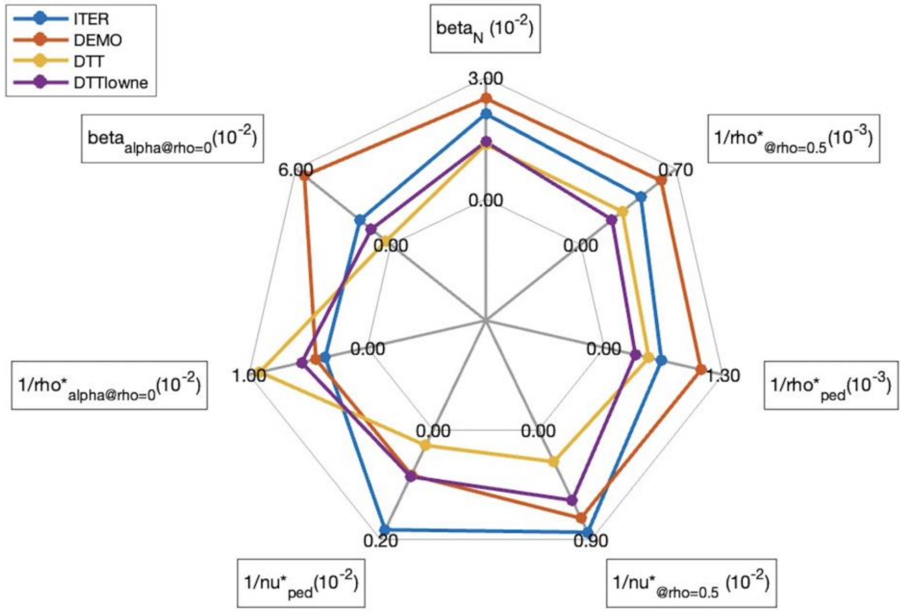
Using the ASTRA or JINTRAC transport frameworks, steady-state simulations have been made for flat-top and dynamic simulations for current ramp-up/-down

Ip ramp-up

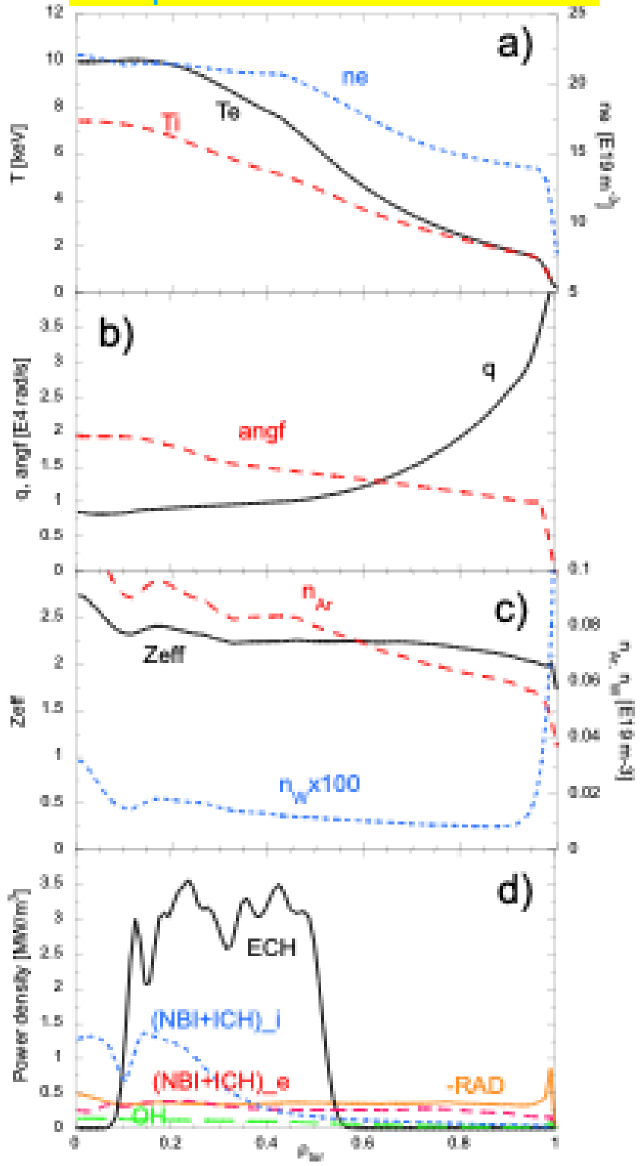


Flat-top for 5.5 MA full power ~ 30-40 sec

DTT vs ITER and DEMO dimensionless parameters



Full power H-mode baseline



ISTP Bari main activities

NUMERICAL ACTIVITIES

- Fluid – kinetic modelling of the Scrape off layer and divertor plasma with SOLPS-ITER code suite. Application to:
  - **present experiments** (JET / WEST, in collaboration with ENEA-Frascati);
  - **future tokamak** (DTT / JT-60SA, in collaboration with DTT).
- Tokamak discharge definition with the fast integrated code METIS in different DTT Scenarios.
- **Fully kinetic Particle-in-Cell model** and code (DESPICCO) of **plasma-wall interaction in the divertor** region of tokamaks (in collaboration with ENEA-Frascati)
- **Fully kinetic Particle-in-Cell model** and code (PICCOLO) of **negative ion sources for neutral-beam injection** (in collaboration with ENEA-Frascati)
- Collision-radiative models for optical emission spectroscopy interpretation
- Database of cross-sections / reaction rates of bulk / surface elementary processes relevant to divertor wall materials (in collaboration with ENEA-Frascati)

EXPERIMENTAL ACTIVITIES

- NEFERTARI experimental diagnostic activities

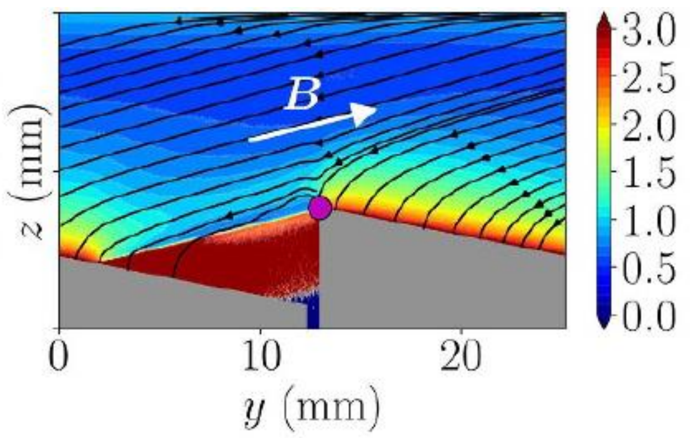
DESIGN ACTIVITIES

- Design of the cleaning / conditioning system of DTT (in Port heaters and glow discharge system)

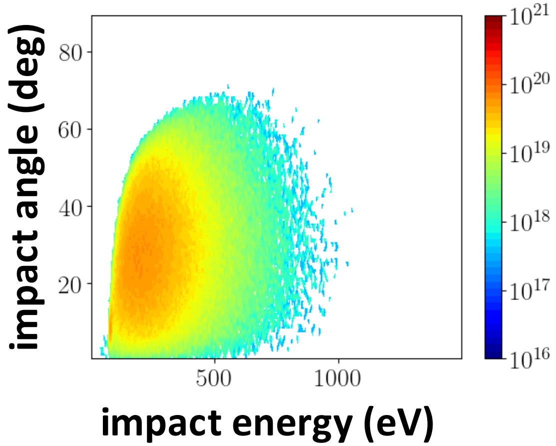
ISTP Bari - in collaboration with Enea Frascati

- 2D PIC Simulation of the plasma-wall transition region in front of **DTT divertor monoblocks** @ OVT, IVT, dome (completed)
  - Self-consistent calculation (effect of sheath electric field and ion Larmor orbits) of plasma particle / heat load to divertor monoblocks, including collisions with recycled neutrals, and plasma-wall interaction effects (electron-induced SEE, thermionic electron emission)
- **Tungsten erosion 1D PIC modeling** (ongoing)
  - Model for sputtering yield and sputtered atoms energy for tungsten walls, as a function of local plasma and magnetic field conditions
- **Plasma-gas recycling coupling** (ongoing)
  - Coupling of plasma and recycled neutrals phases at the divertor

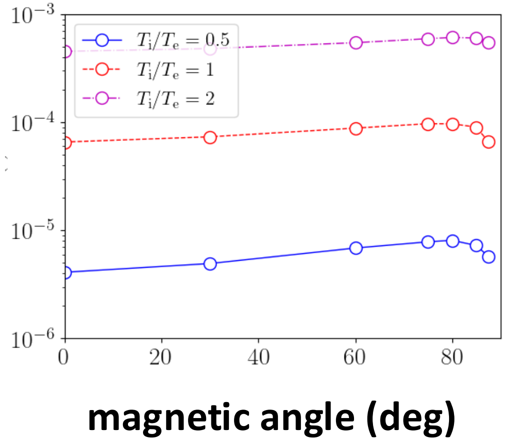
Ion Mach number @ OVT monoblocks



2D ion impact distribution function



sputtering yield



F Cichocki, P Innocente, V Sciortino, P Minelli, F Taccogna Plasma Physics and Controlled Fusion 66 (2), 025015 (2024)
F Cichocki, V Sciortino, F Giordano, P Minelli, F Taccogna, Nuclear Fusion 63 (8), 086022 (2023)

ISTP Bari present or planned contributions to DTT

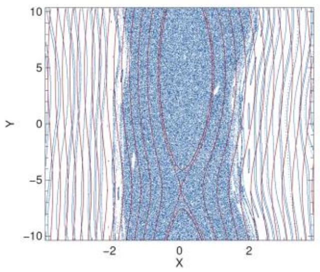
- 2D simulations of plasma-wall interaction across poloidal/toroidal gaps, at the **OVT/IVT monoblocks** for a SN configuration, and at the **dome monoblocks** for an XD configuration. Simulations consider the real monoblocks geometry
- Modeling of the **2D ion impact distribution function** (vs impact energy and impact angle) and the corresponding **sputtering yield/emission energy**, **as a function of local plasma and magnetic field conditions** (from a large set of 1D PIC simulations) → inputs for ERO code to study sputtering and re-deposition from walls more accurately
- Assessment of the spatial profile of the sputtering induced on the DTT limiter, in relevant scenarios, using the above sputtering model
- 2D simulations with SOLPS-ITER of Scenario A-SN and E-NT
- METIS simulations of B-SN Advanced Scenario
- Design of the in-port heaters and GDC system

CNR ISC Torino main activities

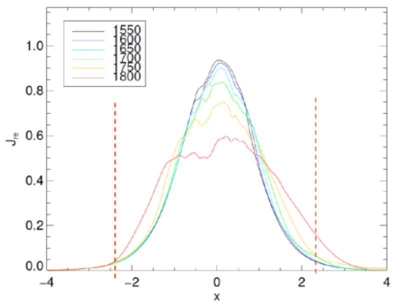
Theoretical and numerical analysis of basic plasma physics processes

Role of **magnetic reconnection in fusion** on:

- **Runaways Electrons physics**: how REs interact with tearing modes in a post disruption plasmas and how chaos impact on the runaways current



Magnetic chaos tends to flatten REs current profile



Beneficial effect on REs termination

D. Grasso et al. JPCS 30, 122114 (2023),
L. Singh et al. PoP 30, 122114 (2023)
Borgogno et al. @Varenna 2024 (paper in preparation)

- **Transport processes**:
  - how the presence of a large magnetic island changes the transport in radial direction (core to edge and vice versa)

Use of integrated modeling of impurity transport to design future devices

Politecnico Torino main activities

- Theory of MHD stability and of kinetic MHD for MCF
- Plasma wall interaction simulation for DTT, DEMO and other devices

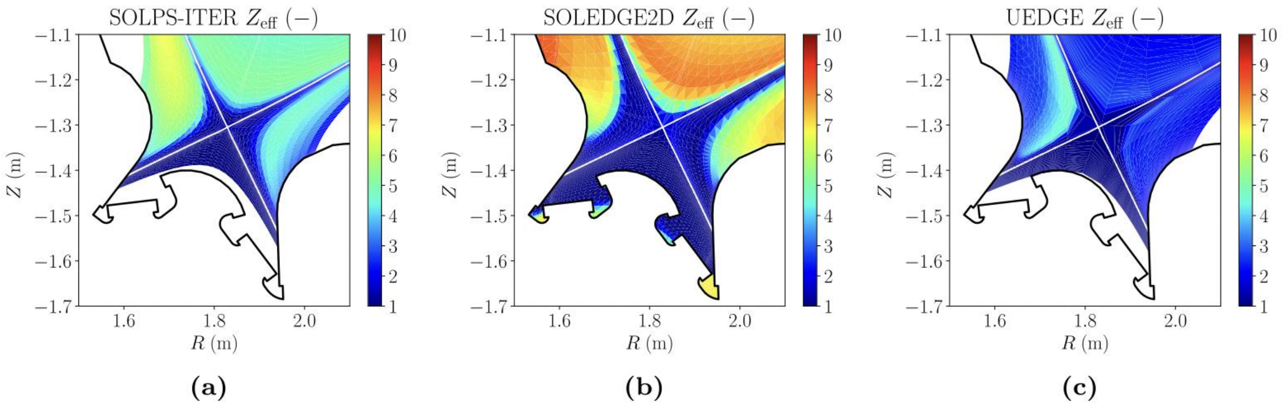


Figure 5. Effective charge distribution $Z_{\rm eff}$ in the divertor for SOLPS-ITER (*a*), SOLEDGE2D (*b*), and UEDGE (*c*).

M. Moscheni et al 2025 Nucl. Fusion 65 026025

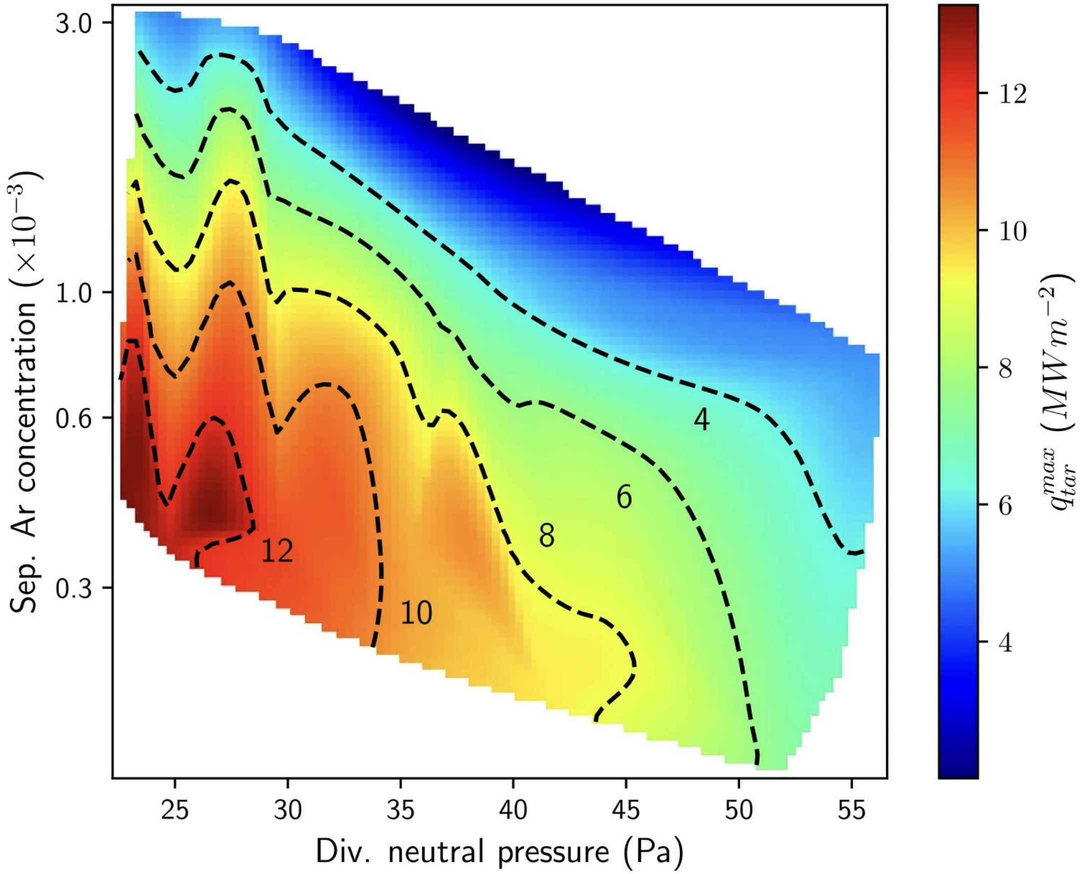
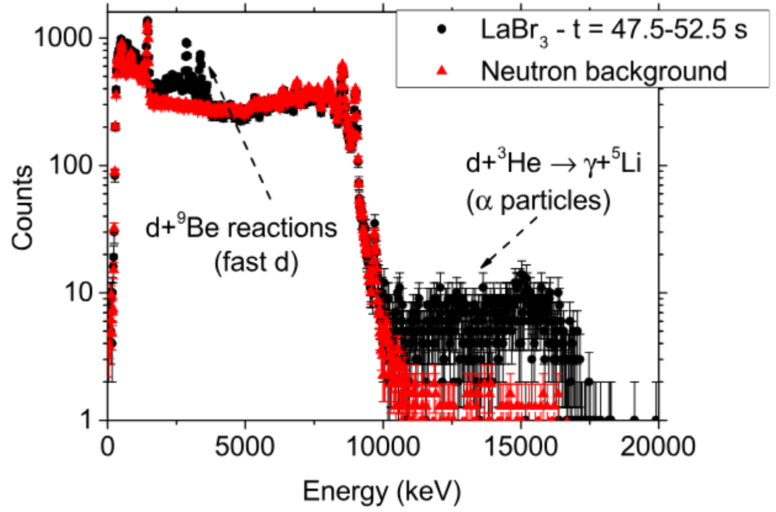


Figure 4. Maximum outer target power flux ($\mathrm{MW\,m^{-2}}$).

Subba, Nucl. Fusion 65 (2025) 086024

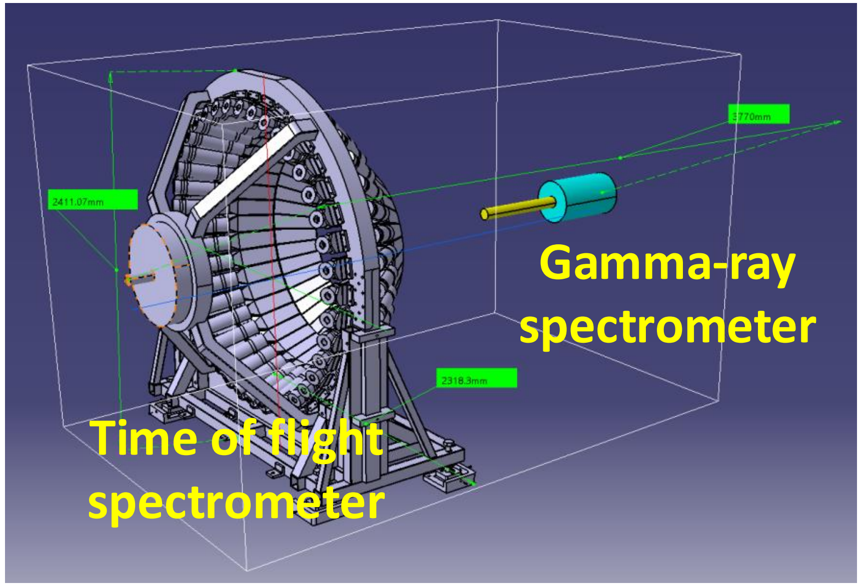
University Milano Bicocca main activities

- Experimental studies on **MeV range energetic particle physics** in tokamaks
- Development of scenarios for **alpha particle generation and studies** in tokamak plasmas without tritium
- Development of **neutron and gamma-ray diagnostics** for energetic particles physics studies in next generation tokamak devices (DTT, ITER, JT-60SA, SPARC)
- Experimental studies and modelling of **edge and divertor physics**:
  - L-H transition characterization and modelling in TCV
  - Experiments and Modelling of divertor and limiter heat fluxes in ASDEX Upgrade and TCV
- Development of a **real-time spectroscopy framework** for reactor relevant control of detachment, plasma content and ion temperature



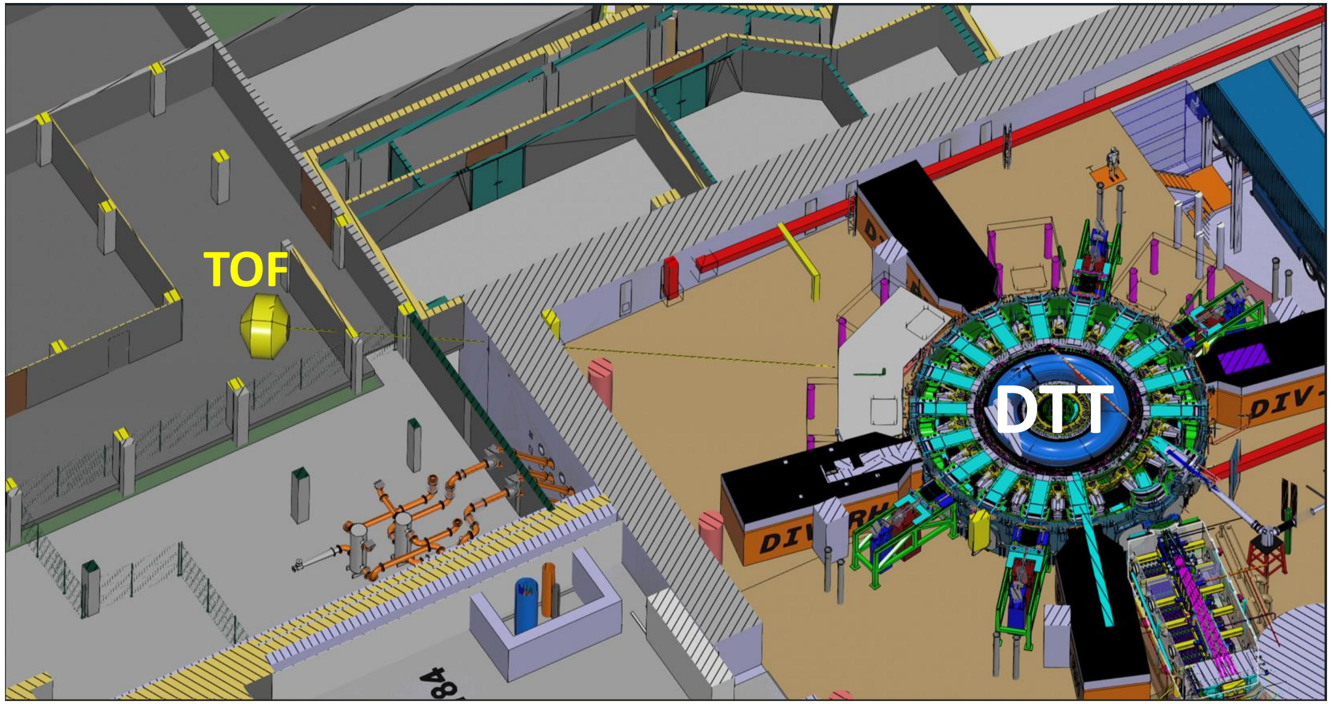
M. Nocente *et al* 2020 *Nucl. Fusion* **60** 124006
S. Mazzi *et al* 2022 *Nature Physics* **18** 776-782

UNIMIB present or planned contributions to DTT



Designing **time of flight neutron spectrometer** for DTT to measure the energy distribution of **deuterons from the ≈500 keV NBI system**.

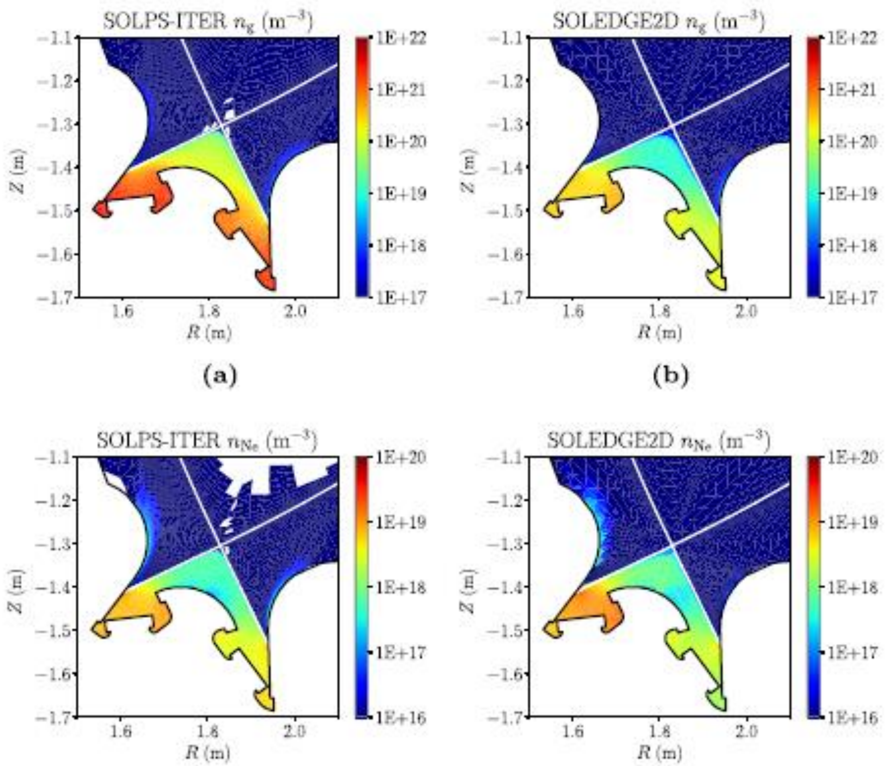
The instrument will be complemented with a **gamma-ray spectrometer** for MeV range ion measurements from the **ICRH** system.



University Milano main activities

- Agreement of cooperation with MPG-IPP Garching on development of gyrokinetic codes
- Refurbishing of bounce-averaged Fokker-Planck FPTM code for ECRH modeling in stellarator

ENI main activities



Divertor (with MIT & POLITO)

Plasma-edge studies with leading institutions (MIT, DTT, UKAEA, PoliTo) to support development and validation of reliable tools for divertor design

Moscheni et al., Nucl. Fusion 65 (2025) 026025

Turbulence (with MIT)

Eni is supporting MIT in the development and extension of the MAESTRO/PORTALS framework, an innovative open-source environment for advanced plasma physics simulations augmented with Machine Learning techniques

Rodriguez-Fernandez et al., Nucl. Fusion 64 (2024) 076034

Artificial Intelligence (with IAEA&MIT)

ni and MIT collaborated in the development of AI models for plasma disruptions prediction and plasma confinement state detection (H- vs L- mode)

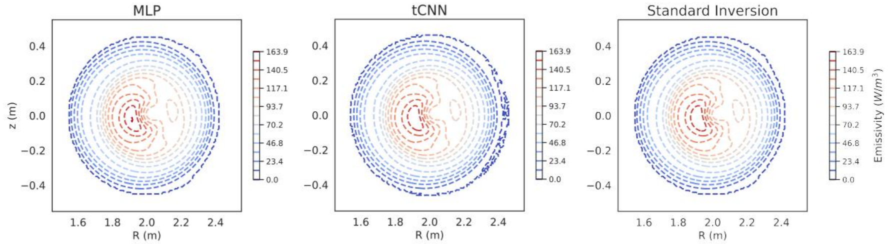
Spangher et al., Res. Sq. (2024) 10.21203/rs.3.rs-4245117/v1

ENI main activities

NN-based SXR Plasma Profiles Reconstruction (with UNIPD)

Development of plasma profiles reconstruction from SXR measurements and tomographic data via the use of neural networks techniques toward real-time algorithms. Eni is also providing access to its powerful HPC6 infrastructure

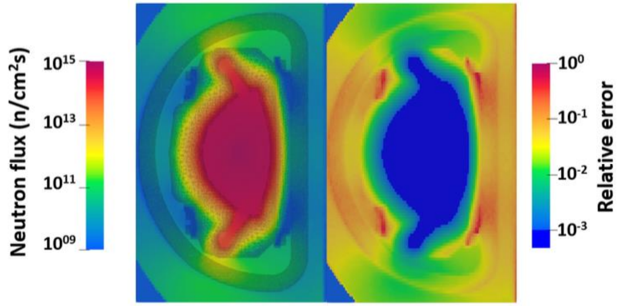
Orlandi et al., 51st EPS Conf. P2.129



Neutronics and Radiation Damage – HTS (with PoliTo)

Monte Carlo simulations are used to map radiation spectra, power deposition, and material damage across an ARC-like reactor to assess and mitigate these effects.

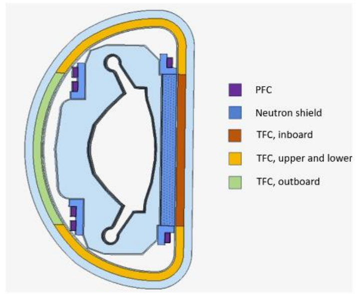
D. Torsello et al., IEEE Transactions on Applied Superconductivity, vol. 35, no. 5, pp. 1-6, Aug. 2025, Art no. 4200206, doi: 10.1109/TASC.2024.3516732



Code cross comparison (with PoliTO)

Cross-code comparison in neutron transport simulations. benchmarking between PHITS and OpenMC on an ARC-like reactor model, supporting the assessment of radiation spectra, power deposition, and material damage in HTS magnets through advanced Monte Carlo analyses

Ledda, Federico; et al.. - FUSION ENGINEERING AND DESIGN. – ISSN 0920-3796. - 202:(2024). [10.1016/j.fusengdes.2024.114323]



Tuscia University main activities

1) DTT Research Plan

2) DTT Commissioning

3) DTT Power Supplies

4) Plasma Edge studies

5) Plasma Scenarios Developments

6) Plasma density Measurements by Interferometer

7) Magnetic measurements development

8) HTS superconductors Studies

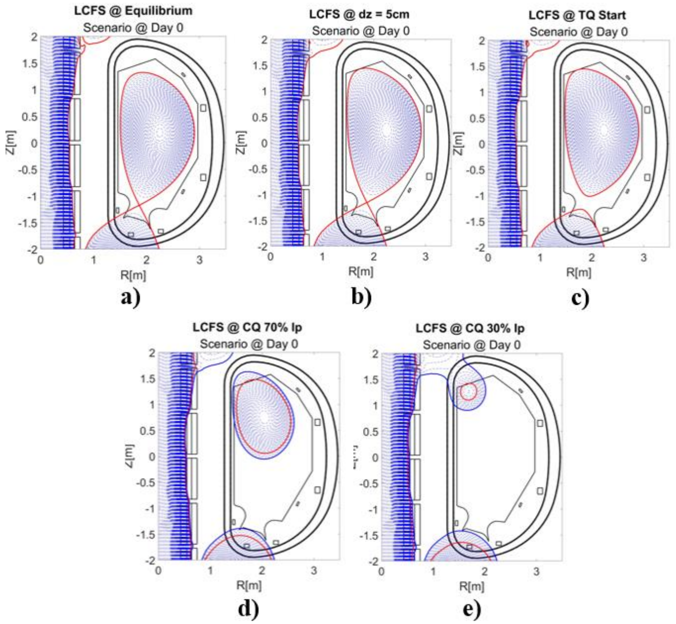
9) Plasma equilibrium in with elliptic shape

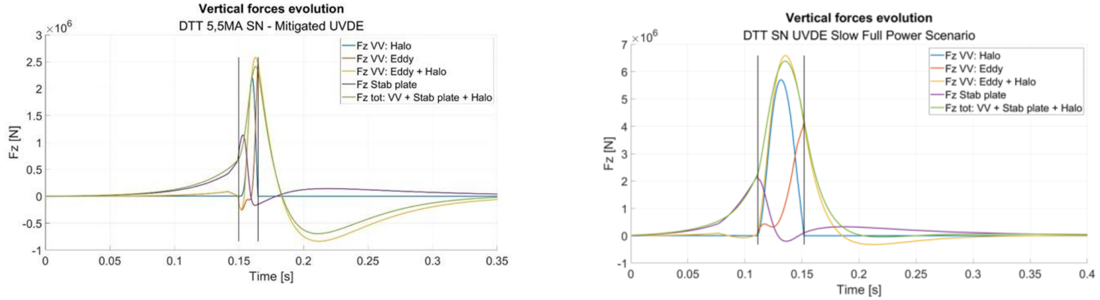
10) Plasma Control: Hardware and Software development

11) Plasma disruption and Run Aways control

12) Studies for the DTT pellet injector

13) MHD stability studies

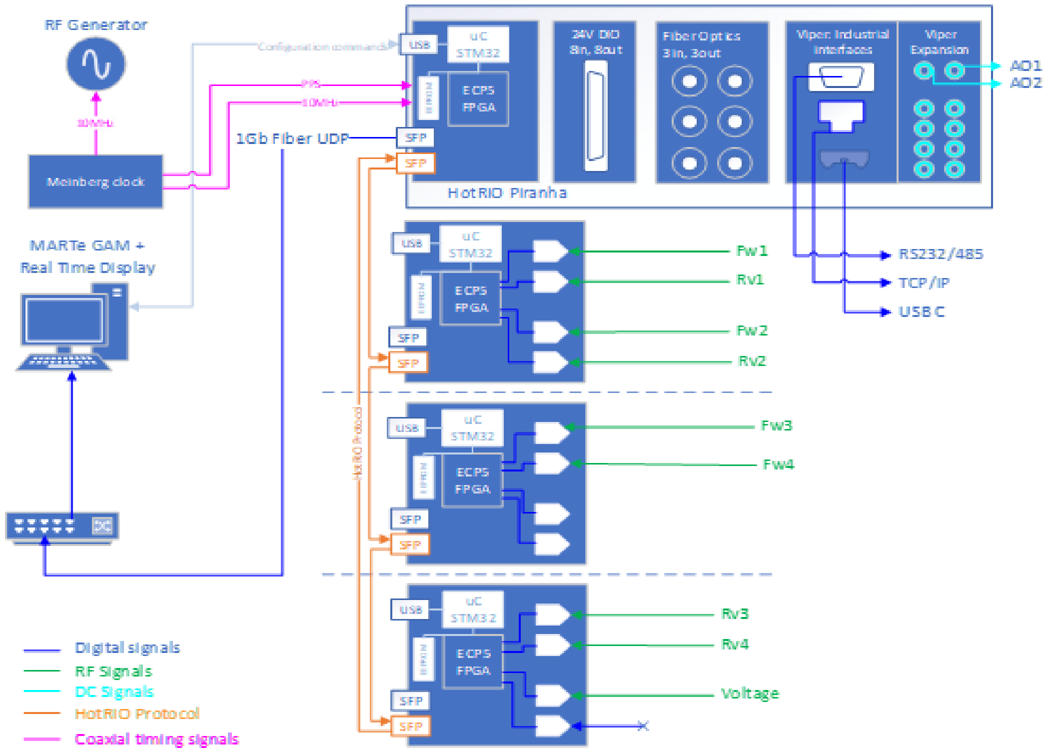




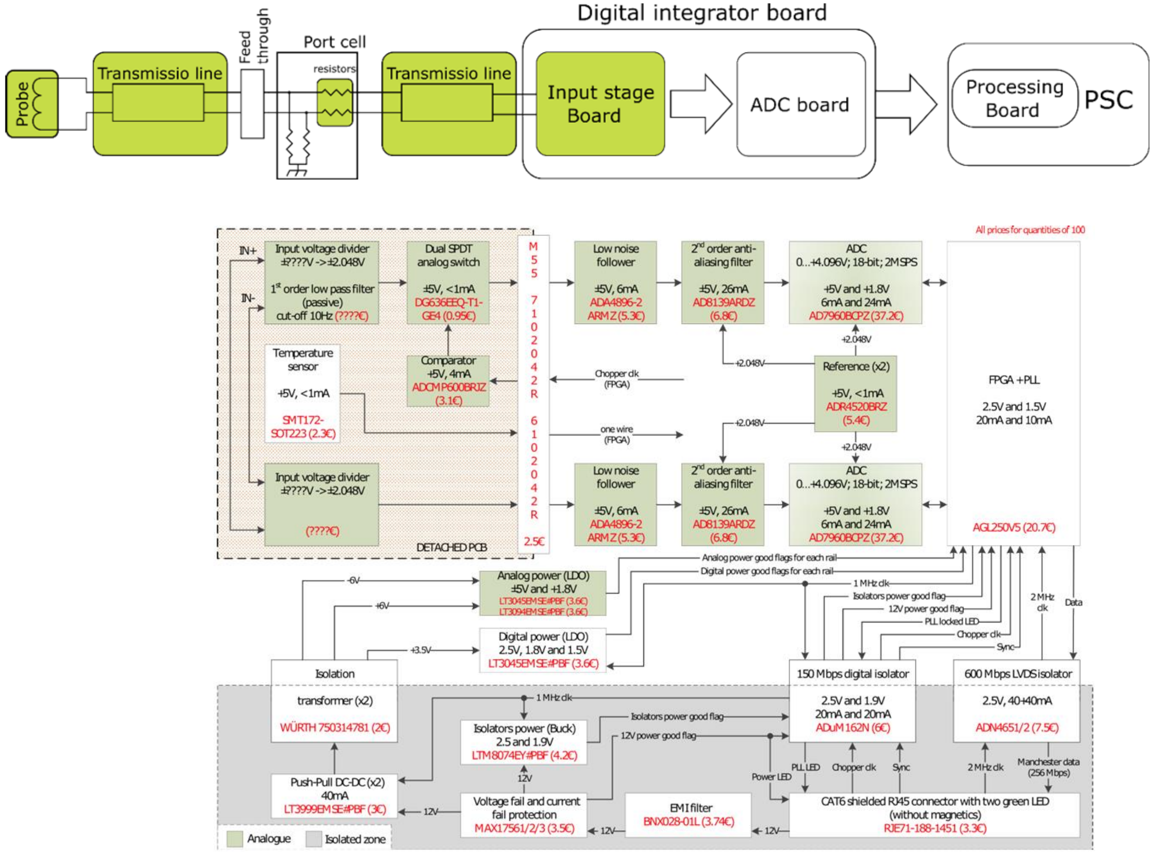
Unmitigated & Mitigated disruptions for DTT

Tuscia University: plasma operations and magnetic diagnostics

Developments of tools dedicated to prepare the plasma operations



HotRIO architecture for
DTT ICRH protection system



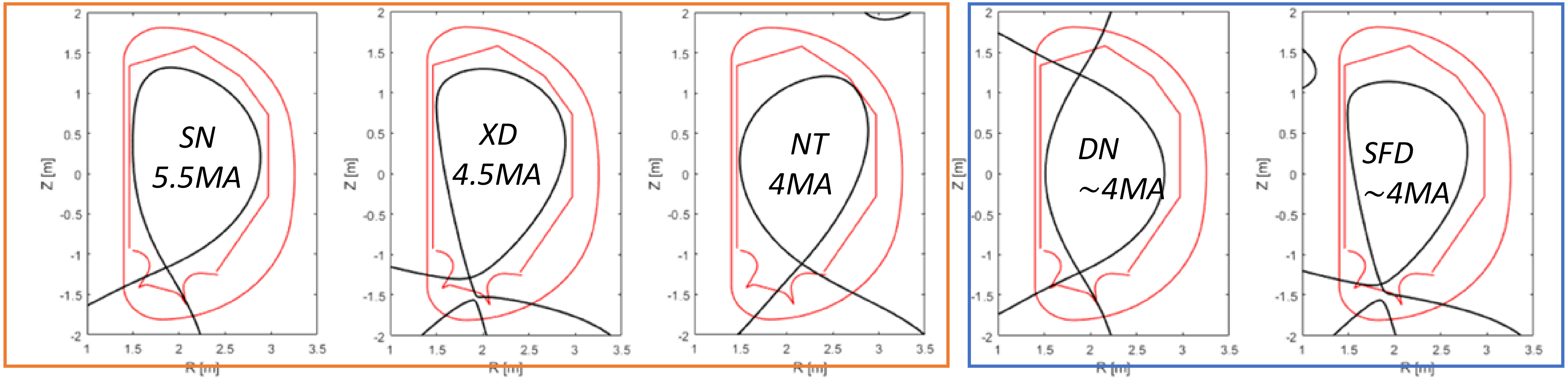
Design of integrators for
DTT magnetic measurements

CREATE main activities for DTT

- Development of plasma electromagnetic scenarios
- Electromagnetic design of the poloidal field coil system
- Coordination of the Plasma Control System (PCS)

CREATE Development of plasma electromagnetic scenarios

DTT reference scenarios | **DTT future scenarios**

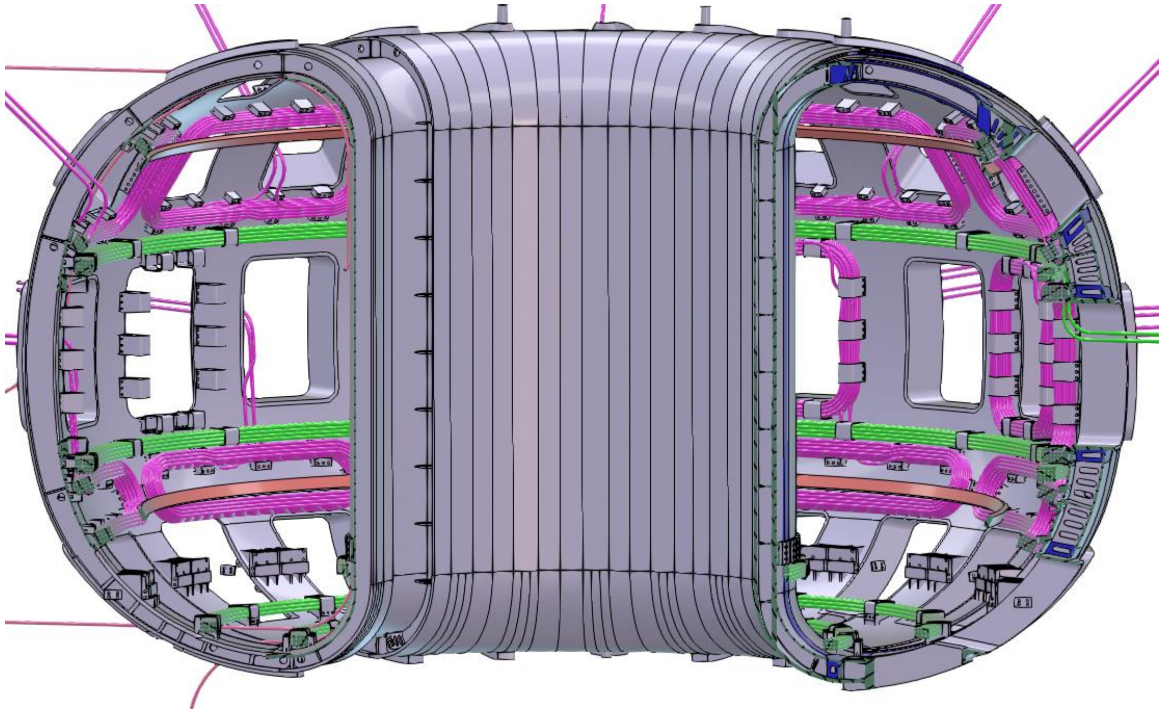


Development of **electromagnetic plasma scenario** (breakdown,ramp-up, flat-top,ramp-down) for the DTT configurations uscing CREATE-NL code.

Coupling del transport codes (METIS, JINTRAC, ASTRA/TGLF) **and SOL codes** (SOLEDGE2D-EIRENE, SOLPS-ITER)

CREATE Electromagnetic design of the poloidal field coil system

- **2 in-vessel equatorial coils** used for
  - Vertical stabilization
  - Fast Radial control
- **3 in-vessel divertor coils** used for:
  - Local modification of the divertor region
  - Sweeping control
- **27 not axisymmetric coils** used for:
  - ELM control
  - Error Field control
- **Stabilizing plates** are also needed to improve the passive stability performance of the DTT scenarios



La Sapienza Rome University main activities

SNNAP (Sapienza Nuclear energy Neutronics And Plasmas) group

- applied physics/engineering physics aspects of both fission and fusion energy research.
- collaborations with the tokamak devices JET, MAST-U, JT-60SA and DTT, contributing with integrated modelling studies based on the JINTRAC suite of codes
- plasma scenarios for the Ignitor compact high-field tokamak.

CNR-INO and University of Pisa activities

Inertial fusion exp & Theory

Roma Tor Vergata University activities

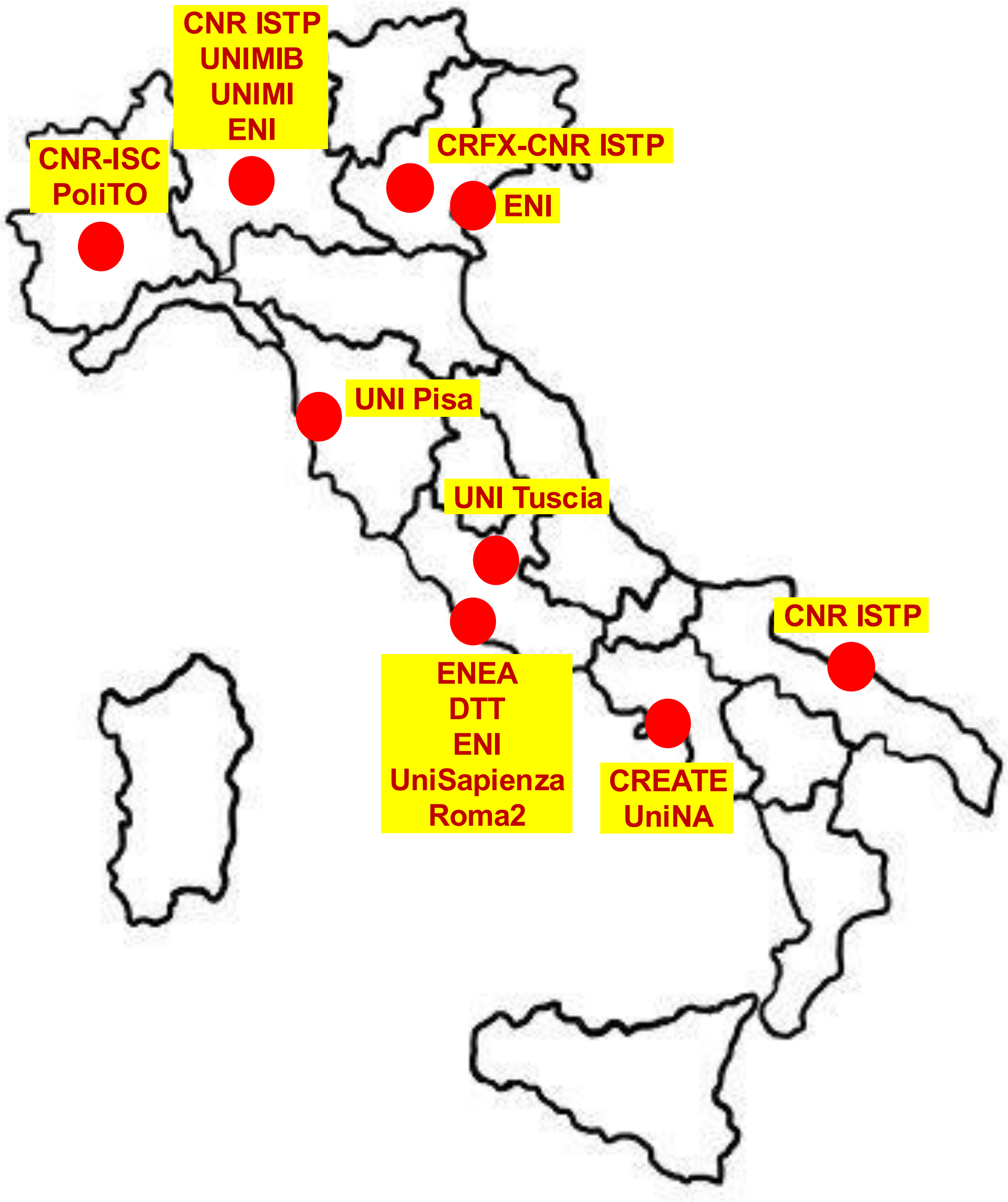
Education

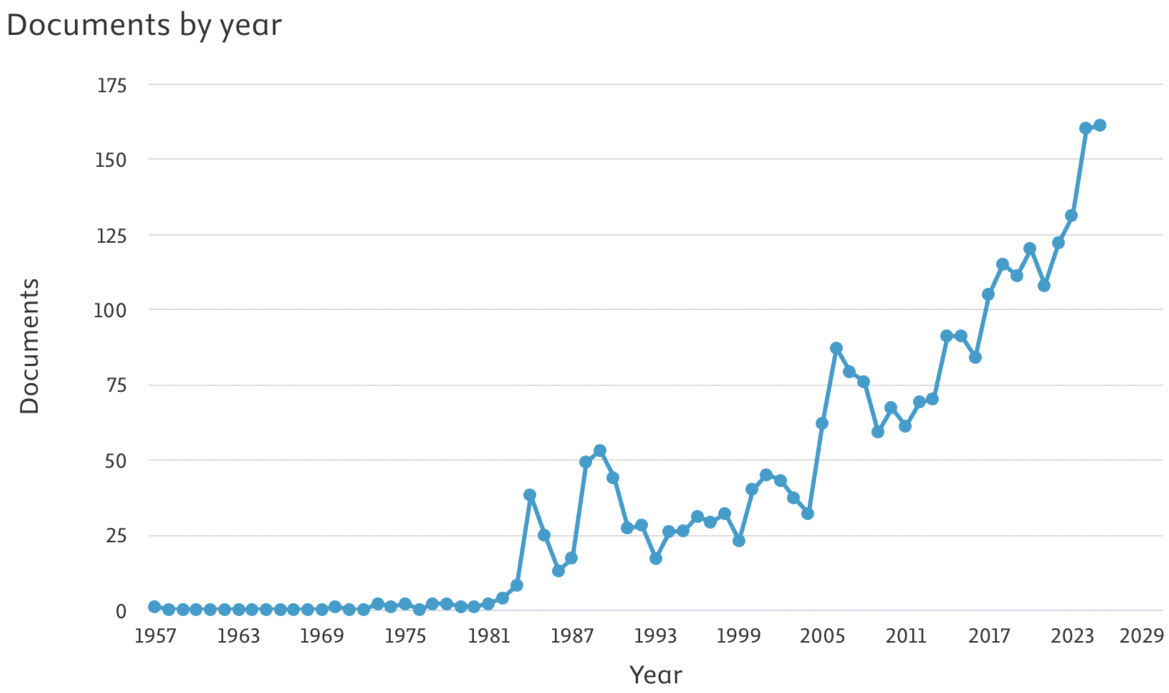
Participation to JET and DTT

Technology & engineering


D.T.T. S.c.a.r.l.
VIETATO
L'INGRESSO
AI NON ADDETTI
AI LAVORI

Plasma in Italy




Documents by year
175
150
125
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Documents
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1963
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2017
2023
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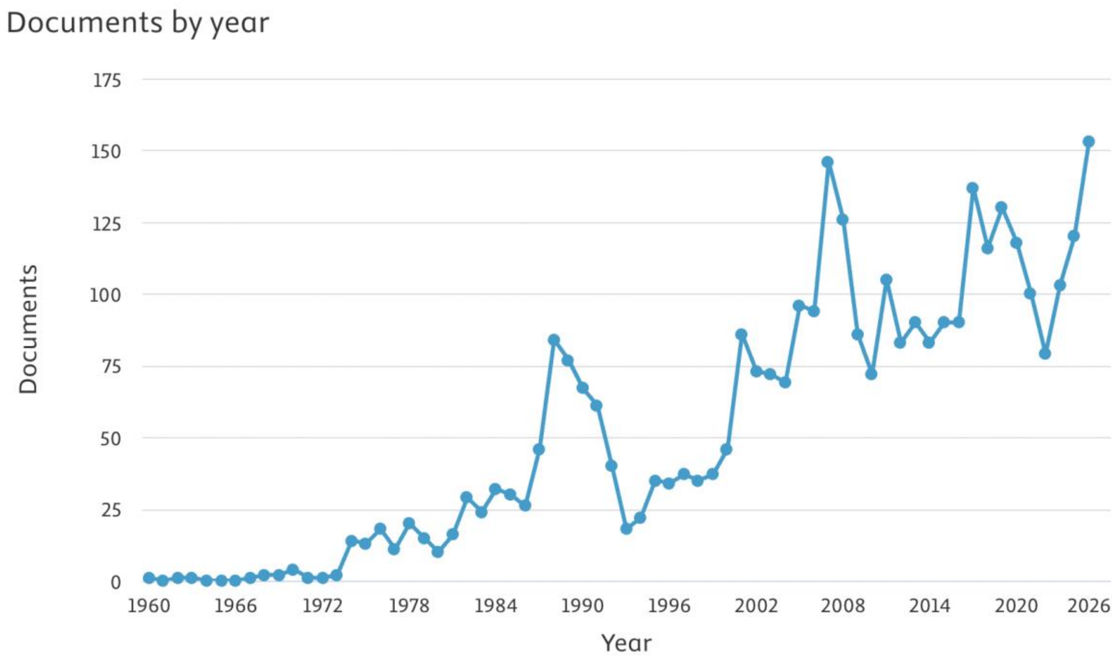
Year


Documents by year
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2014
2020
2026
Year

Advanced query

Search within	Search documents
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AND	
Article title, Abstract, Keywords	FUSION
AND	
Affiliation	germany

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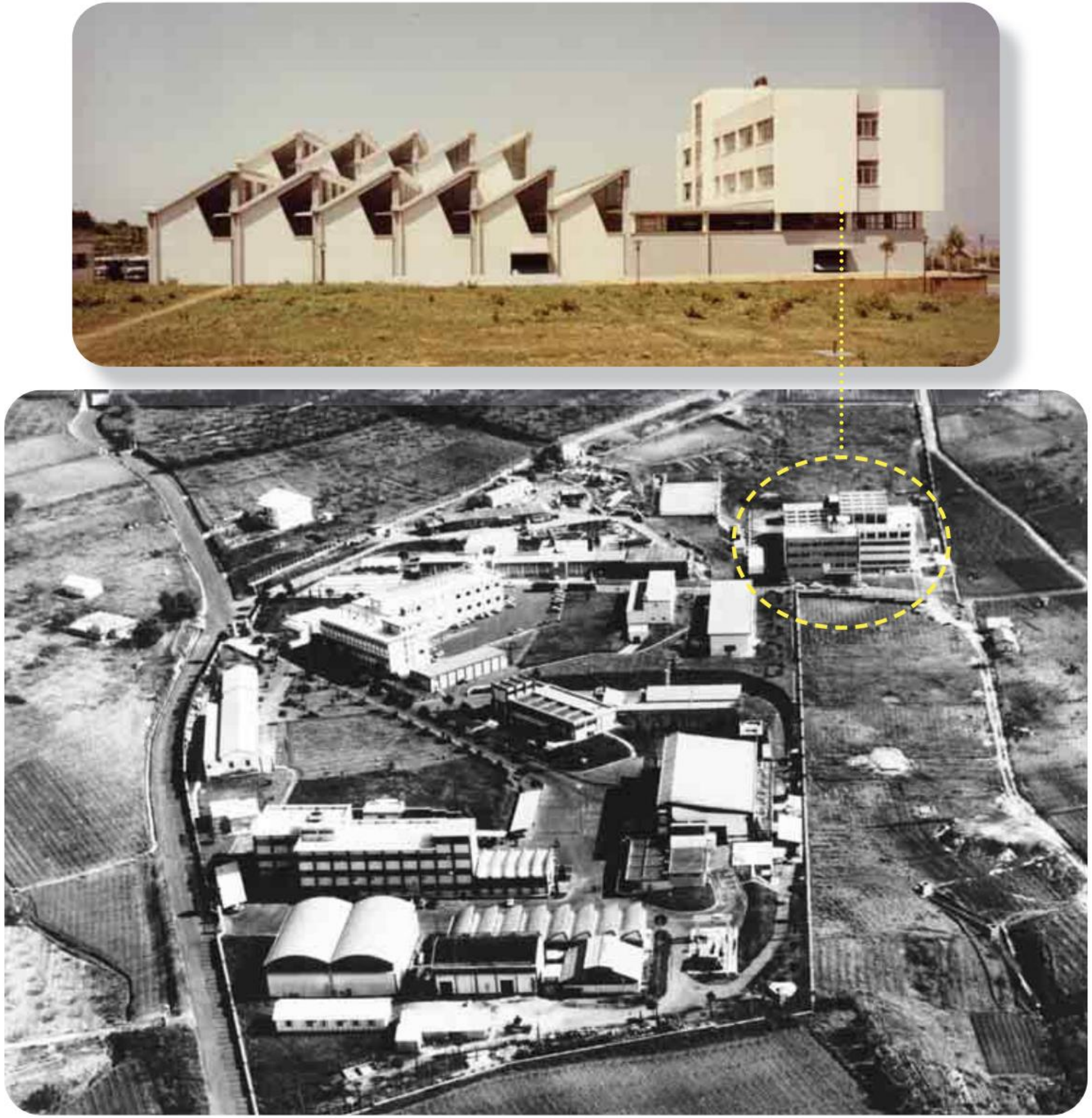
Limited to Computer Science	208
Limited to Mathematics	149
Biochemistry, Genetics and Molecular Biology	179
Chemical Engineering	102
Medicine	89
Environmental Science	54
Earth and Planetary Sciences	35
Health Professions	32
Pharmacology, Toxicology and Pharmaceutics	14

Italy, plasma and fusion: a long history

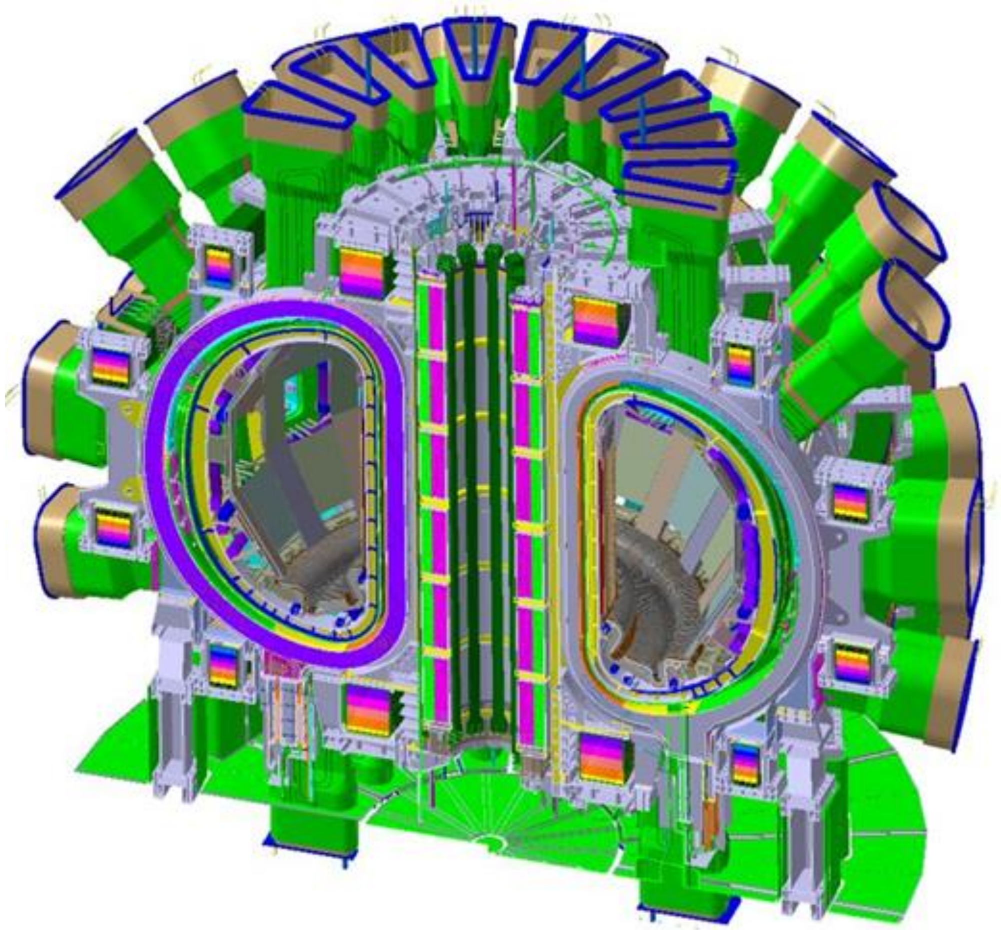
1960 – 2010

50 anni di ricerca sulla fusione in Italia

years of fusion research in Italy

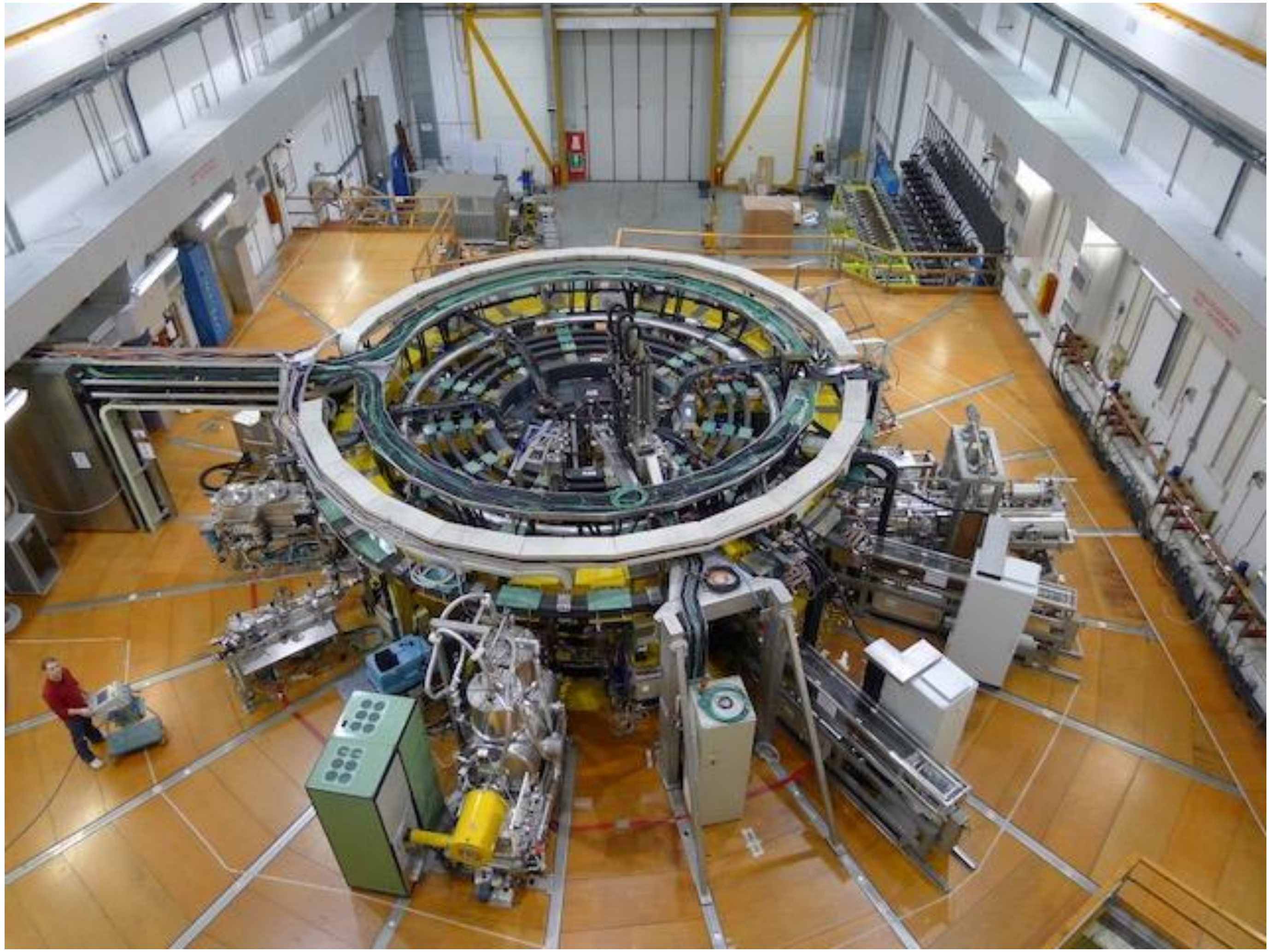


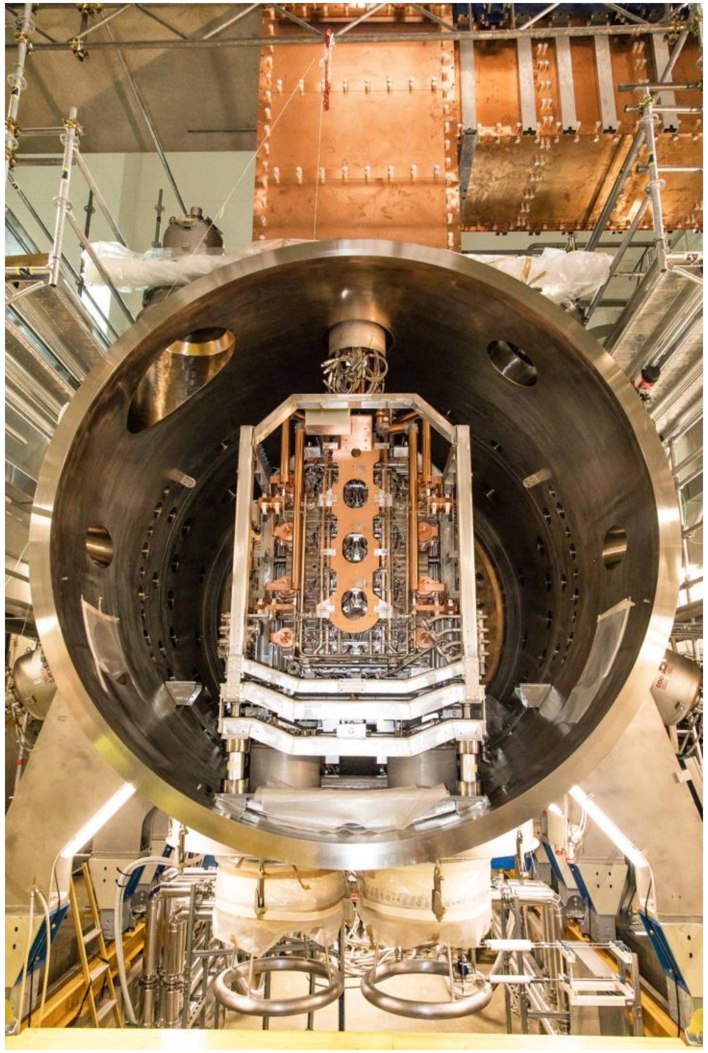
DTT, a national enterprise



ENEA ITALIAN NATIONAL AGENCY FOR NEW TECHNOLOGIES, ENERGY AND SUSTAINABLE ECONOMIC DEVELOPMENT
CETMA
Consiglio Nazionale delle Ricerche
create
CONSORZIO RFX Ricerca Formazione Innovazione
eni
INFN
Politecnico di Torino
Università degli Studi di Milano Bicocca
Università di Roma Tor Vergata
Università degli Studi della Tuscia

Consorzio RFX Padova: RFX & NBTF

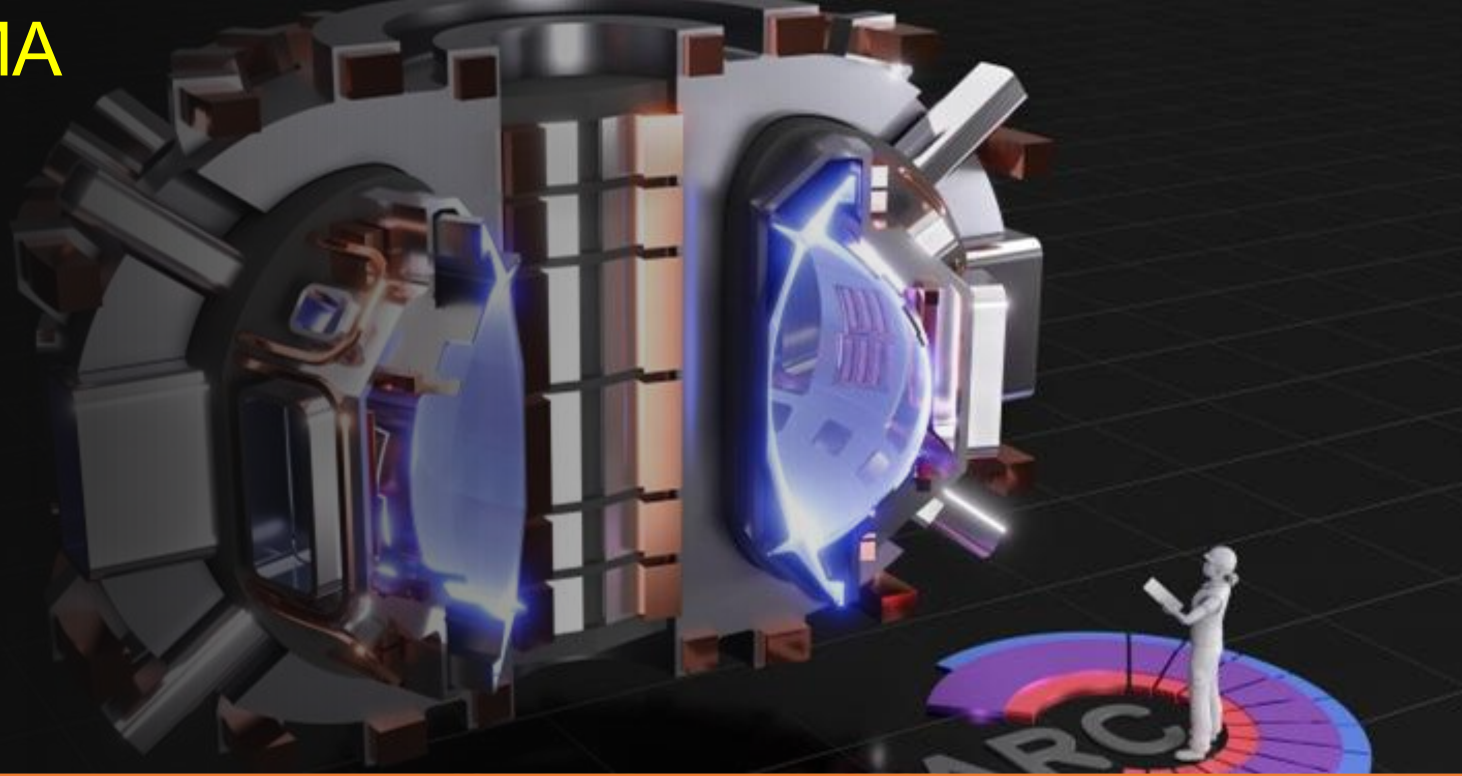




Energia da fusione, l'energia che imita le stelle

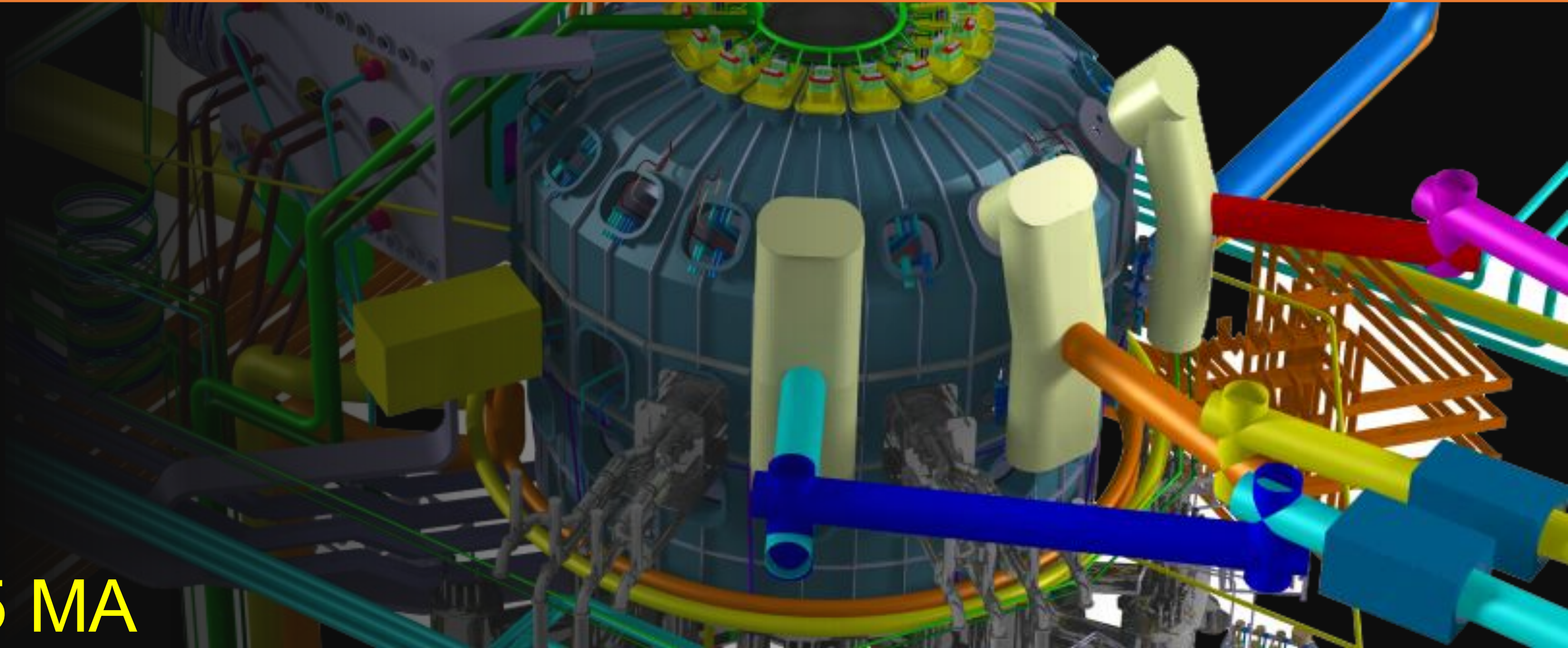
Una soluzione tecnologica che genera grandi quantità di energia con un processo sicuro, sostenibile e virtualmente inesauribile.

SPARC 12.2 T – 8.7 MA



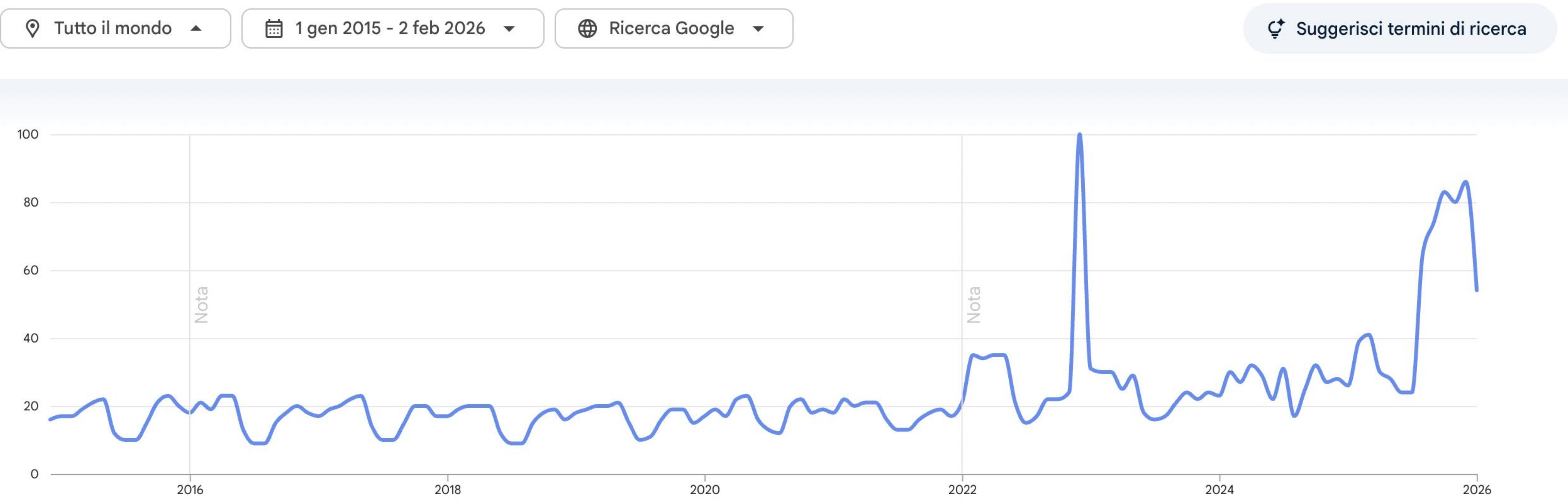
The high field pathway DTT & SPARC

$$P_F \propto \beta_t^4 B_{T,o}^4$$



DTT 5.85 T – 5.5 MA

Google trend “nuclear fusion”



G7 energy ministers – Oct 30-21, 2025, Canada

Government of Canada Gouvernement du Canada

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Statement on Nuclear and Fusion Energy

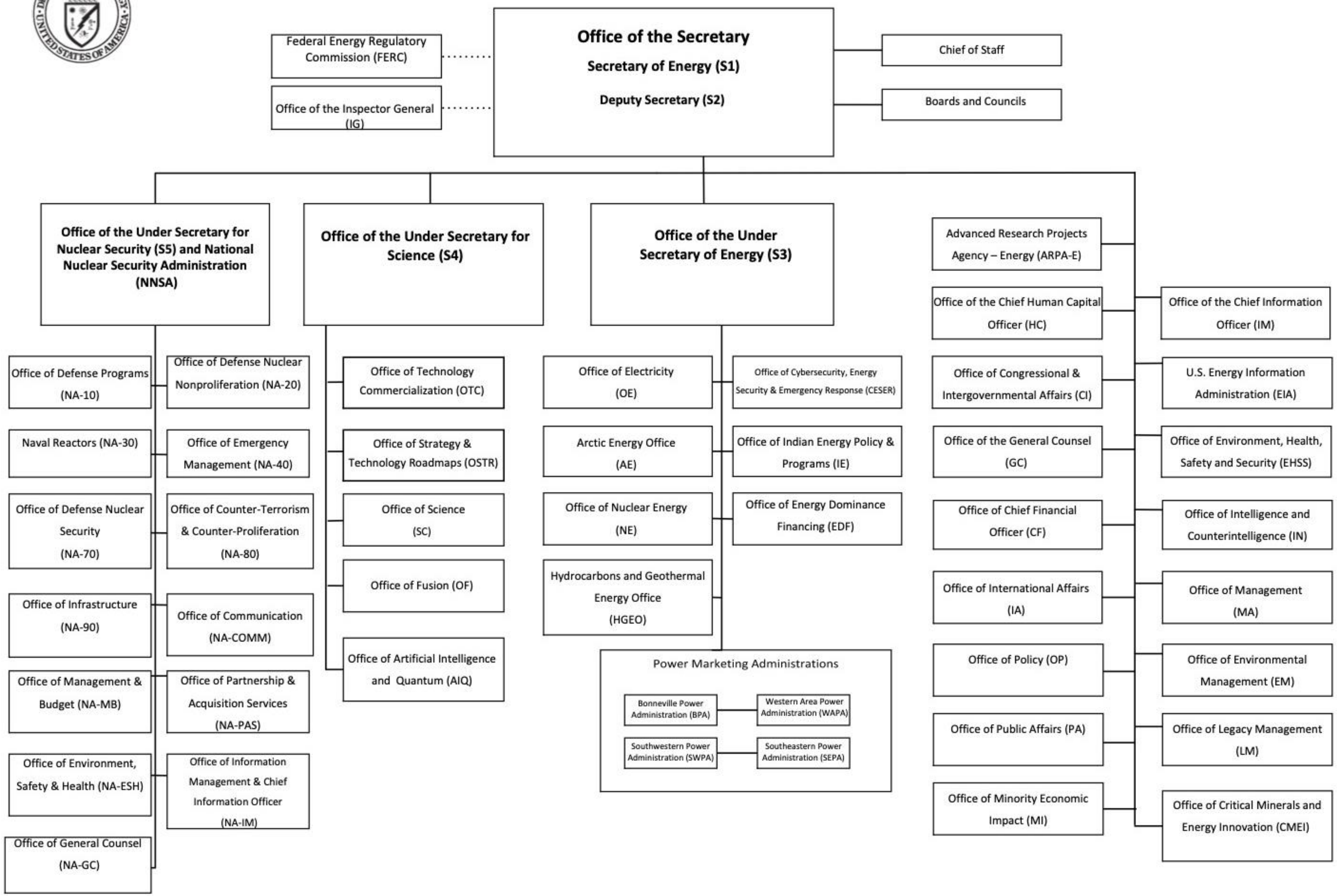
From: Natural Resources Canada

Statement

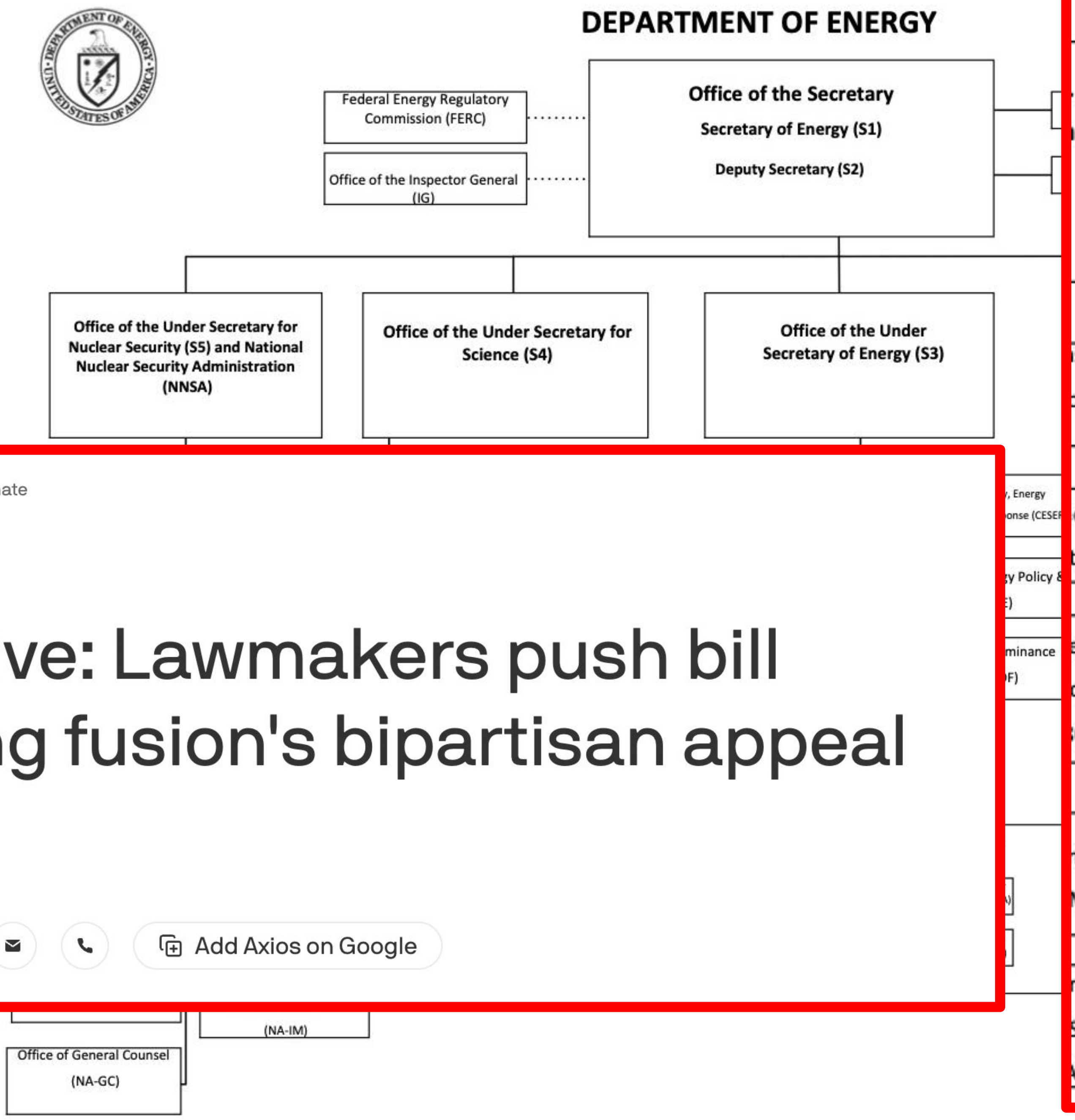
October 31, 2025

*«We recognize that, in the future, fusion energy has the potential to make a significant contribution to meeting the growing demand for energy. Acknowledging global advancements and investment in fusion energy technology, we underscore **the importance of sustained international collaboration** on fusion energy with trusted partners, encouraging private investments and public engagement».*

DEPARTMENT OF ENERGY



Updated November 20, 2025



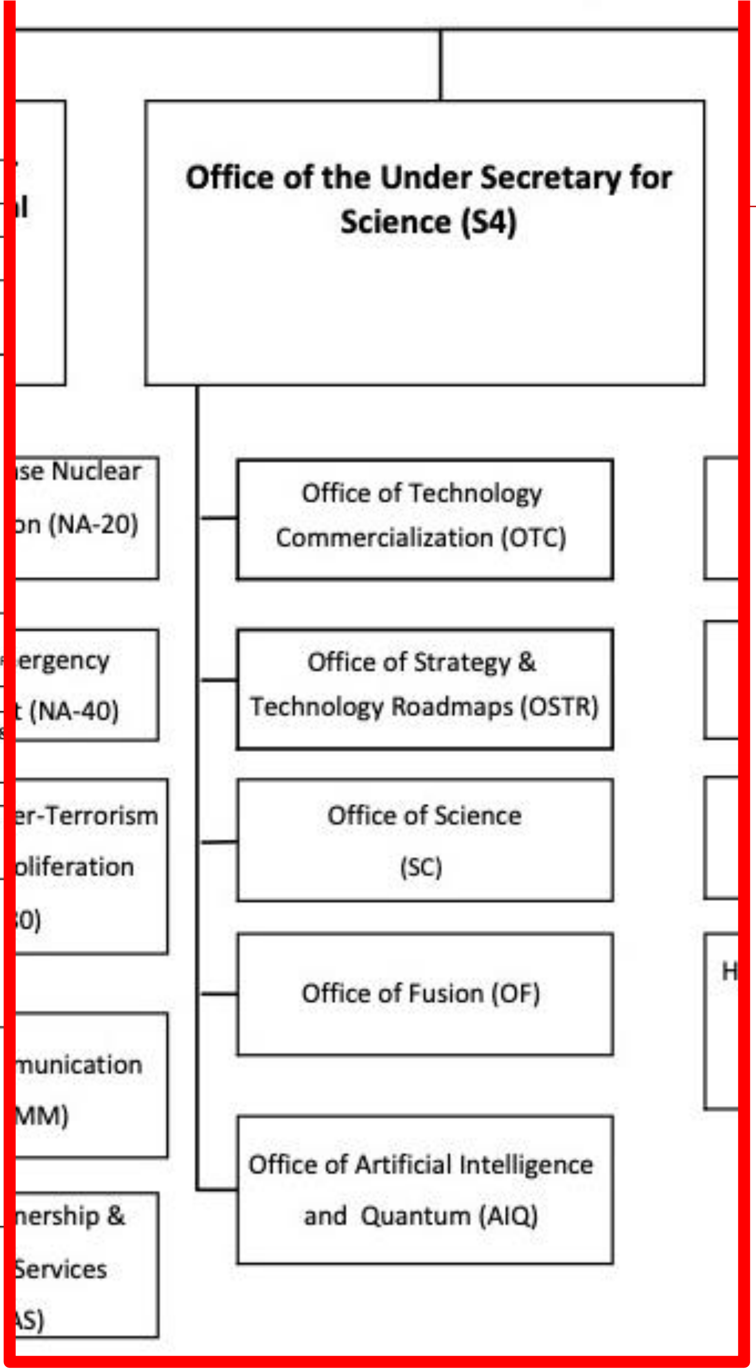
Dec 15, 2025 - Energy & Climate

Exclusive

Exclusive: Lawmakers push bill showing fusion's bipartisan appeal

Amy Harder

Add Axios on Google

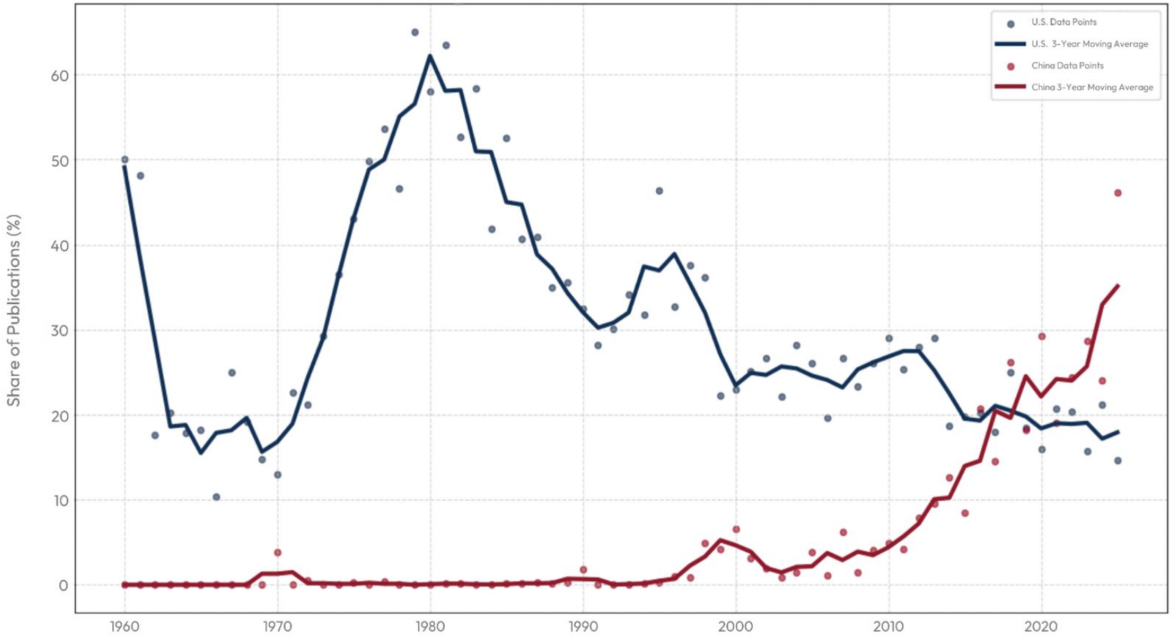


Updated November 20, 2025

Worldwide strategic competition

from the report «Fusion Forward – Powering America's Future» Commission for the scaling of fusion energy

Percentage of Publications in the Journal "Nuclear Fusion" (U.S. versus China)



The percentage share of publications by researchers affiliated with Chinese institutions in the journal Nuclear Fusion has sharply increased over the past decade, overtaking the United States.[17]

«We conservatively estimate that, since 2023, China has mobilized at least $6.5 billion for fusion infrastructure supporting a variety of approaches, though this figure could be as much as $13 billion»

«China … is producing ten times more fusion Ph.D. graduates than the United States, a direct function of government funding»

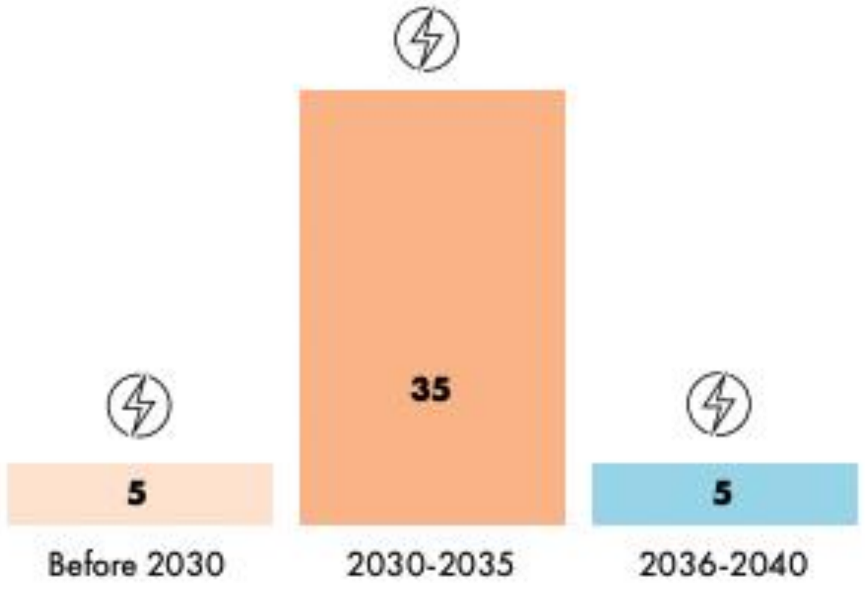
https://www.scsp.ai/wp-content/uploads/2025/10/Fusion-Commission-Fall-2025-Report-Draft.pdf

Fusion energy forecast

Fusion Industry Association – «The global fusion industry in 2025» Report

8. When do you anticipate your company will operate a commercially viable pilot plant?

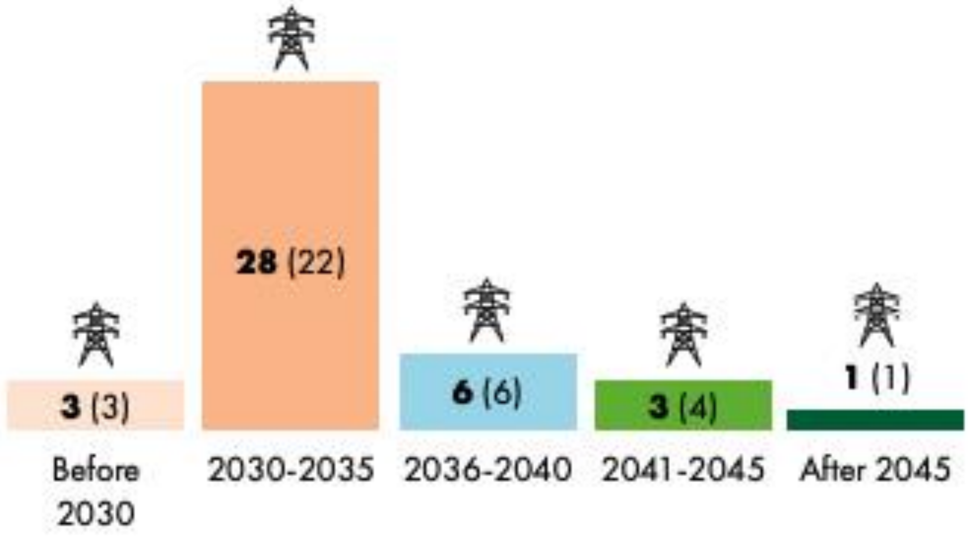
(45 responses)



9. When do you anticipate your company will deliver power to the grid?

(41 responses)

*Last year's response in brackets



CAMERA DEI DEPUTATI N. 2669

DISEGNO DI LEGGE

PRESENTATO DAL PRESIDENTE DEL CONSIGLIO DEI MINISTRI

(MELONI)

E DAL MINISTRO DELL'AMBIENTE E DELLA SICUREZZA ENERGETICA

(PICHETTO FRATIN)

Delega al Governo in materia di energia nucleare sostenibile

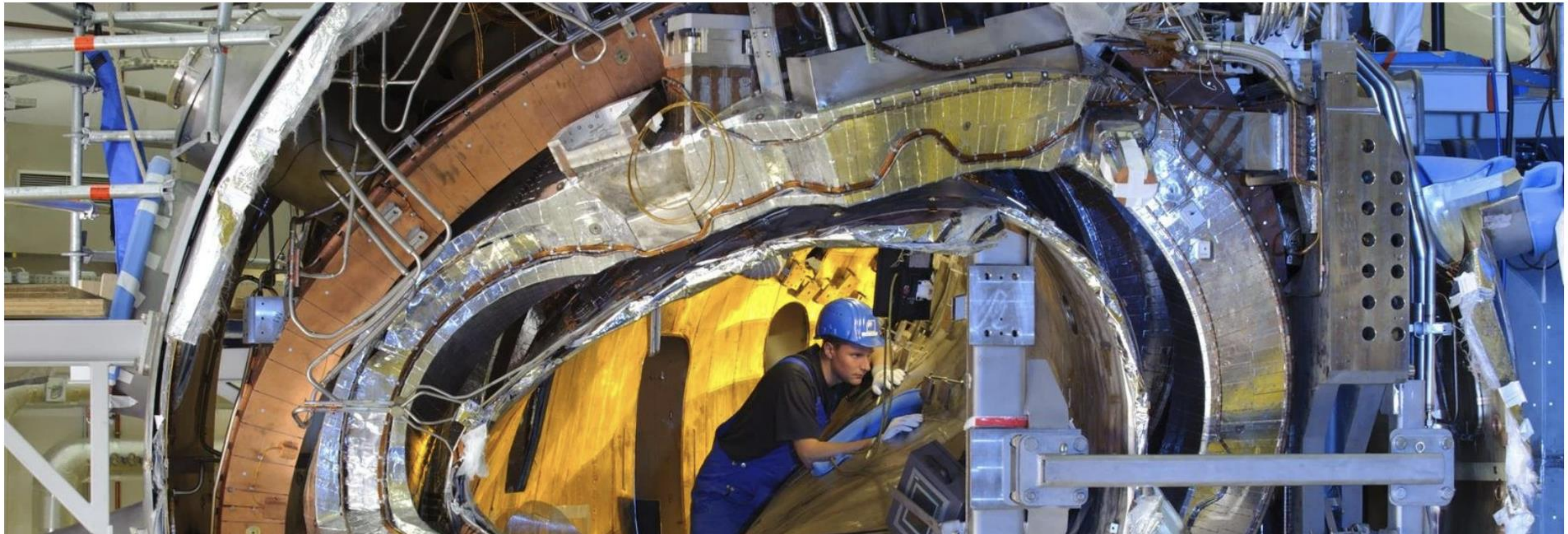
Presentato il 17 ottobre 2025

FUNKE | Windkraft nur Übergangslösung

Friedrich Merz setzt auf Kernfusion: Wann könnte ein Reaktor Strom liefern?

Berlin. Bundeskanzler Merz setzt große Hoffnungen auf Kernfusion als saubere Energiequelle. Aber wie weit ist die Forschung in Deutschland?

Von Björn Hartmann, FUNKE Zentralredaktion
28.01.2026, 09:37 Uhr



So far, Germany is the leading EU country pursuing fusion energy, having clinched a €7 billion deal with the multinational energy company RWE in 2023 to build a pilot plant by 2035.

German Chancellor Friedrich Merz has vowed to create a regulatory framework for fusion technology in Germany and Europe. Speaking at the World Economic Forum in Davos, he directly criticised his predecessors' decision to shut down the country's nuclear plants.

ACCADEMIA NAZIONALE DEI LINCEI

CENTRO LINCEO INTERDISCIPLINARE «BENIAMINO SEGRE»

Mercoledì 11 febbraio 2026, alle ore 10, il Prof. Piero Martin (Professore ordinario di Fisica sperimentale presso l'Università di Padova, distaccato presso il Centro Linceo) terrà un seminario sul tema:

FUSIONE TERMONUCLEARE: COME, QUANDO, DOVE E PERCHÉ
UNA RIFLESSIONE SU UN SETTORE IN PROFONDA TRASFORMAZIONE

Le rivolgo il cordiale invito ad intervenire.

IL DIRETTORE DEL CENTRO LINCEO
Ciro Ciliberto

RSVP

Il seminario si terrà nella sede accademica nella sala Levi-Civita (2° piano).

Si prega di segnalare la propria partecipazione inviando una email a centrolinceo@lincei.it