1st Conferenza Italiana Plasmi (CIP)

Tavolo progettuale tematico Magnetic Confinement Fusion Plasmas

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EUROfusion

EUROfusion integrates R&D in fusion science and technology

29 Countries

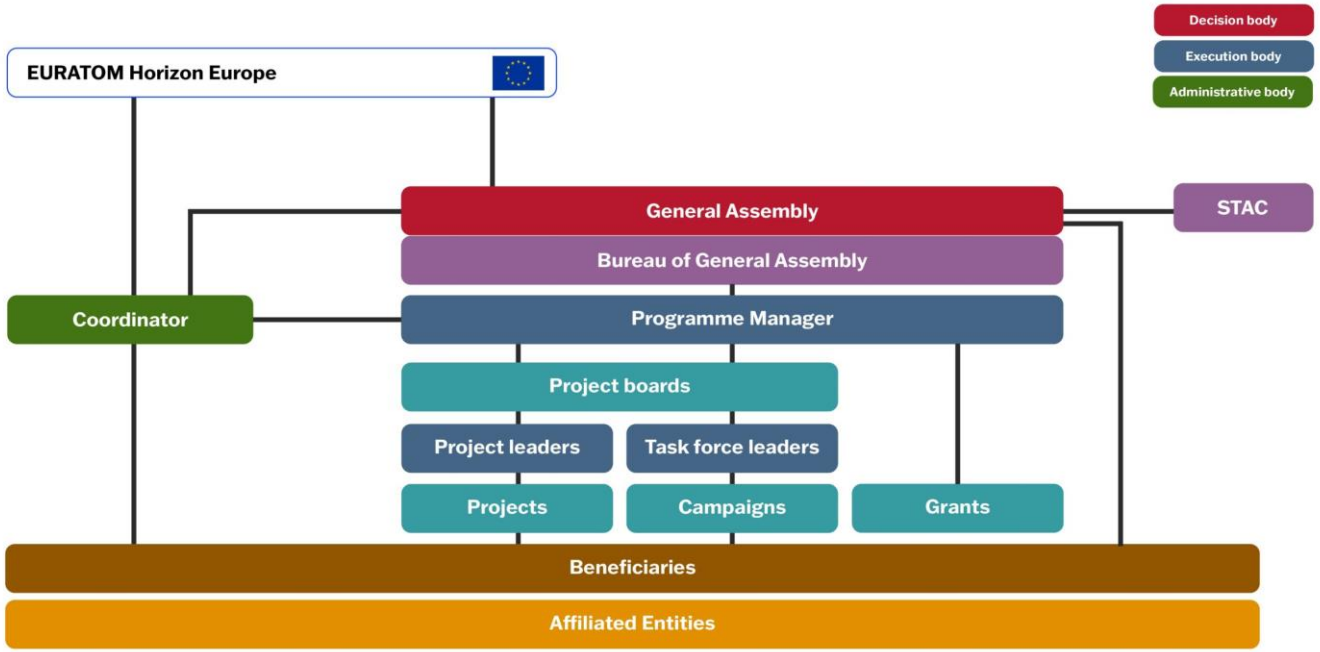
31 Research Institutions

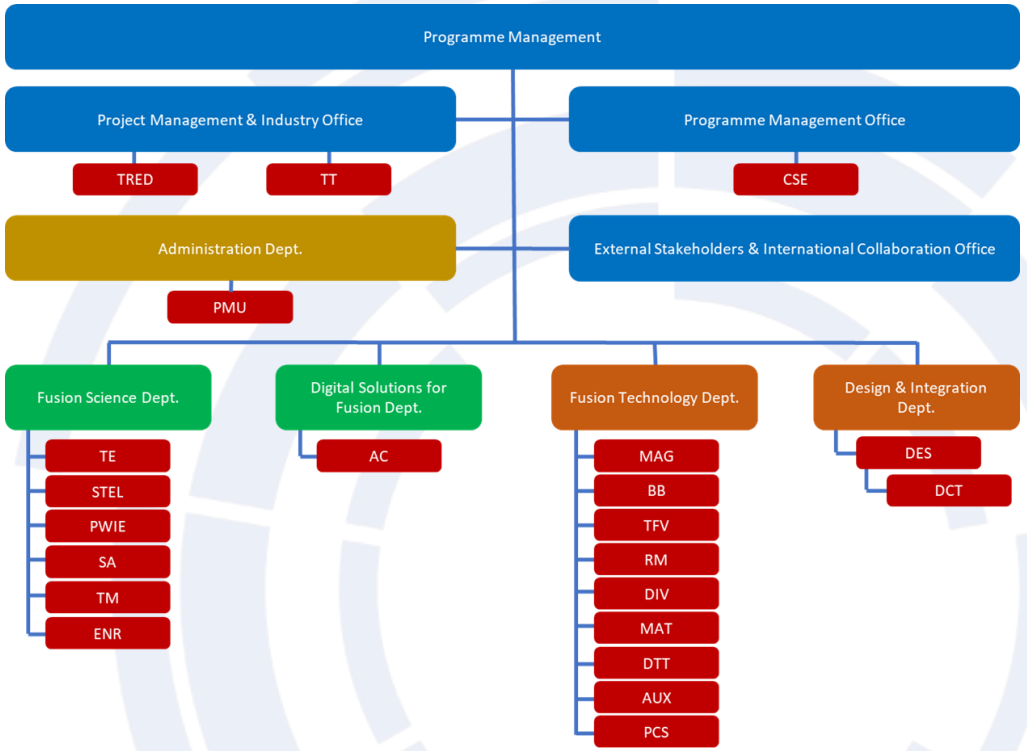
164 Universities

~1000 MSc & PhD students

~5000 Fusion Researchers & Support Staff

EUROfusion Structure – programmatic bodies





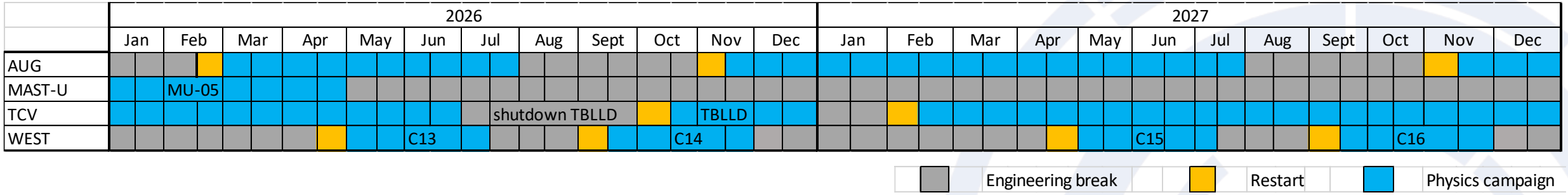
- ***EUROfusion is a co-funded activity*** with 55% of the budget (~550 Mio Euro) contributed by EC in 2021-2025 (FP9) and 45% by Beneficiaries – Grant extension AWP submitted to EC and under evaluation. Significant reduction of resources in 2026/2027 (~ ¼) w.r.t. 2021-2025. Then next FP10 (2028-2032).
- ITER support is the highest priority within Physics for EUROfusion, with several formerly additional DEMO items now part of ITER-relevant activities, and the entire experimental programme covering ITER priorities
- The coordination of the project/campaigns related work done in Work Packages (e.g. WP SA, C. Sozzi) and Task Forces (WP TE, E. Tsitrone/N. Vianello)
- Presently 4 departments, including Fusion Science Department (head : M. Wischmeier)

EU facilities assisting the scientific and technological basis towards a FPP

A. Fasoli SOFT 2024

Tokamak Machine availability for 2026-2027

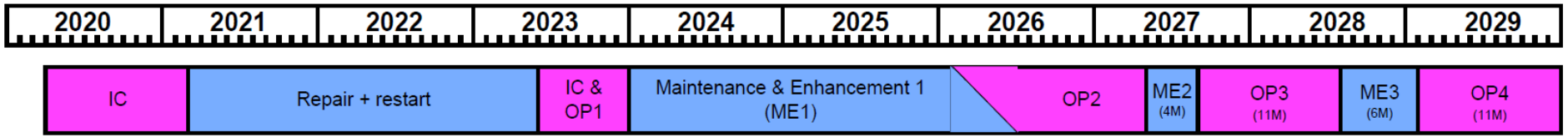
Tentative timeline for TE devices in 26-27



- Funding opportunity, in particular for participation on site will be reduced in 2027 w.r.t. 2025

% of op time	2025	2026	2027
AUG	50	40	27,5
TCV	40	35	27,5
WEST	40	40	27,5

JT-60SA



[Obsolete BASC-34, December 2024]

EUROfusion strongly involved in activities towards approved W transition of JT-60SA (Coordinator C. Sozzi)

WP-Theory and Modelling : EUROfusion development of numerical codes to

- Develop and apply validated predictive tools enabling reliable extrapolation to unexplored parameter regimes
- Address critical knowledge gaps on the path to ITER and fusion power plants that experiments alone cannot resolve within the next decade
- Bridge gaps through robust, first-principles simulations and the best available extrapolation methods
- Execute through **11 Theory, Simulation, Verification & Validation (TSVV)** projects already established
- Activity organized in a work package to facilitate exchange between experimentally oriented activity and development of numerical capabilities

Digital Innovation for Digital Twin Environment (DTE) for 2026/2027

Area Title	Objectives of selected projects
PDT: Pulse Design Tool Extension	• Simulator-agnostic DTE integration with ITER relevance; coupled transport/equilibrium codes; validated pulse design tools
DDM Data-Driven Predictive Modelling	• Machine-agnostic digital twins for real-time plasma prediction & control; AI/ML-enhanced breeding blanket systems; ML-based monitoring & integration
ENG Integrated Physics/Engineering Framework	• Scalable DT of fusion power plants; integrated tokamak design (EU-DEMO & ITER); breeding blanket coupling (plasma/fuel cycle/thermal-hydraulics); thermal protection; ITER diagnostics & validation frameworks
VIS Advanced Visualisation Tools	• Verification-oriented interactive visualization & decision support for DTE

+

DMP Data Management Plan	• Further develop EUROfusion-wide data infrastructures and management to guarantee FAIR access to experimental and simulation data

International collaborations and opportunities

- Continued even if reduced financial support for missions for European researchers to facilities outside Europe for undertaking joint experiments under ITPEA (International Tokamak Physics and Engineering Activitites) activities in 2026
- EU-US ELM-free joint working group drafted a document for the joint research on small/no-ELM regimes (QH-, EDA H- & QCE-, I-mode, NT, XPR) – pending signatures
- Collaboration with KSTAR drafted towards joint activities with metal wall on KSTAR – pending signatures
- BEST: following the 1-year activity on the development of a joint research plan it was launched on November 24th 2025. The potential participation to the exploitation is not yet formalized

Looking ahead

- As indicated in Mario Draghi's report (2024) on the future of European competitiveness, we need to create **'a stable and predictable fusion ecosystem for industrial innovation, leveraging the ITER project, while ensuring a clear technology development roadmap**.'
- The **EU's first-ever Fusion Strategy is planned for publication by early 2026**, positioning Europe at the forefront of global fusion development and accelerating commercial fusion energy in the EU. It will deliver on commitments made in the Clean Industrial Deal and the Affordable Energy Action Plan and also build on recommendations from the Draghi Report on European Competitiveness.
- **EUROfusion is Committed to deliver input for the definition of the EU Fusion Strategy** (expected mid-2026) by the European Commissioner for Energy and Housing Dan Jørgensen

Looking ahead: presently 2 variants under consideration

- EUROfusion established a working group for the definitition of the requirements for a **FPP** (Fusion Pilot Plant) that contributes to enhancing the TRL of all systems enabling the design of a **FOAK** (First of a Kind) aims at a full integration of all technologies including closed fuel cycle and power production at commercially enabling scale (TRL 8 (qualification) and 9 (mission operation)).
- The Pilot Plant is primarily a technology-qualification facility complementary to ITER, it does not necessarily have to explore burning plasma physics and w/o having electricity production as target
- 2 Different projects based either on Beam-Target fusion for high neutron fluence and “fast” dpa, or on purely wave electron heated as test for integrated systems

Look ahead: National Programs

Although far in the future and still in brainstorming modes and at different stage of consolidation also several National Labs are thinking about next steps:

- WEST Phase 3 upgrade: increase Steady State ECRH power, testing ITER-like tungsten first wall compatible with high radiated power -1000s
- TCV : Working group established for TCV next steps: several candidates solutions (including W PFC but not only)
- AUG: expected to continue operation for ~ 10 years but Germany is going towards Stellarator and possible PPP initiative for a burnings stellator reaching Q =1

Backup

11 Theory, Simulation, Verification and Validation (TSVV) Targeted physics Challenges for ITER & FoaK

Validated predictive capability of the L-H transition and pedestal physics

- TSVV-A: H-Mode and Small/No-ELM Pedestals
- TSVV-K: Neutral Particle Models

2. Validated predictive capability for heat/particle exhaust

- TSVV-B & C: Plasma Particle/Heat Exhaust (Fluid & GK Simulations)
- TSVV-K: Neutral Particle Models

3. Validated predictive capability for plasma-wall interactions with W wall

- TSVV-D: PWI with Metallic Components
- TSVV-E: Impurity Sources, Transport, and Screening

4. Validated predictive capability for disruptions and Runaway Electrons

- TSVV-F: Tokamak Disruptions and Runaway Electrons

5. Validated predictive capability for burning plasmas in tokamaks & stellarators

- TSVV-G: Physics of Burning Plasmas

6. Validated Integrated modelling framework for core/edge physics with metallic wall

- TSVV-H: Reliable Prediction of Plasma Performance and Operational Limits in Tokamaks

7. Validated framework for Stellarator Optimization

- TSVV-I & J: Stellarator Core Turbulence and Optimization