EUROfusion's Vision for Advancing the European Fusion Energy Roadmap

Ambrogio Fasoli

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EUROfusion integrates R&D in fusion science and technology

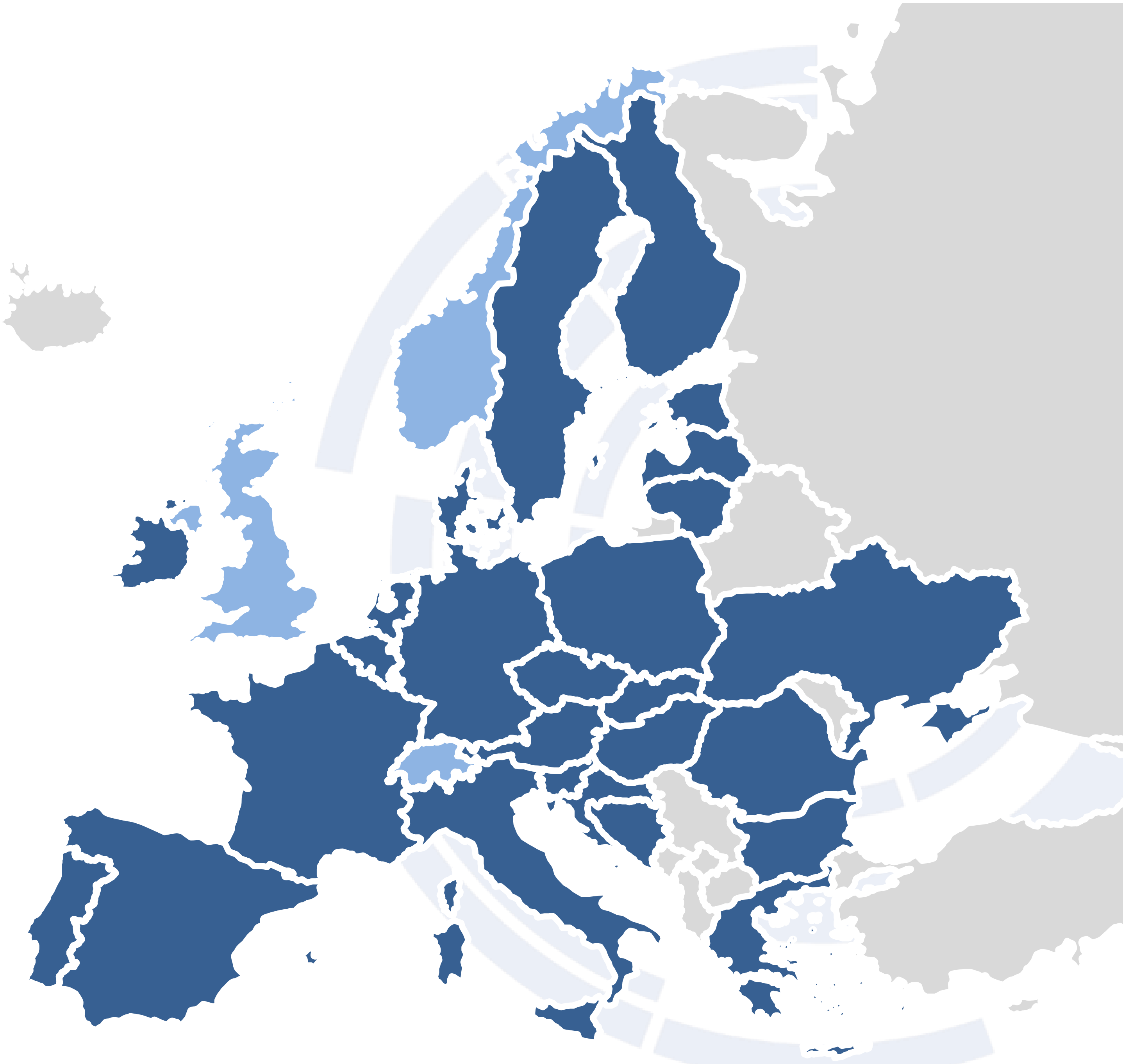
29 Countries

31 Research Institutions

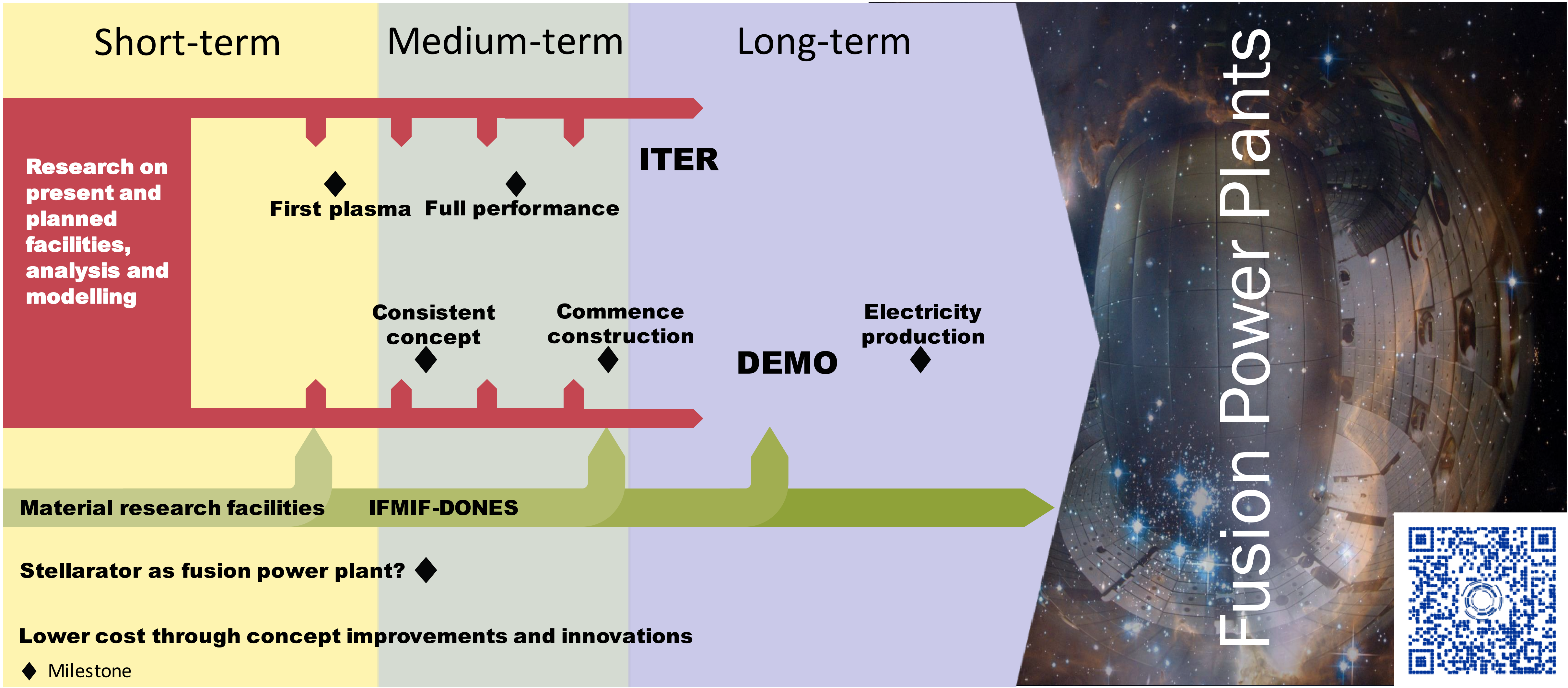
167 Affiliated Entities including 15 Industrial Partners

800 MSc and PhD students

4000 Fusion Researchers & Support Staff



European Fusion Research Roadmap – under revision



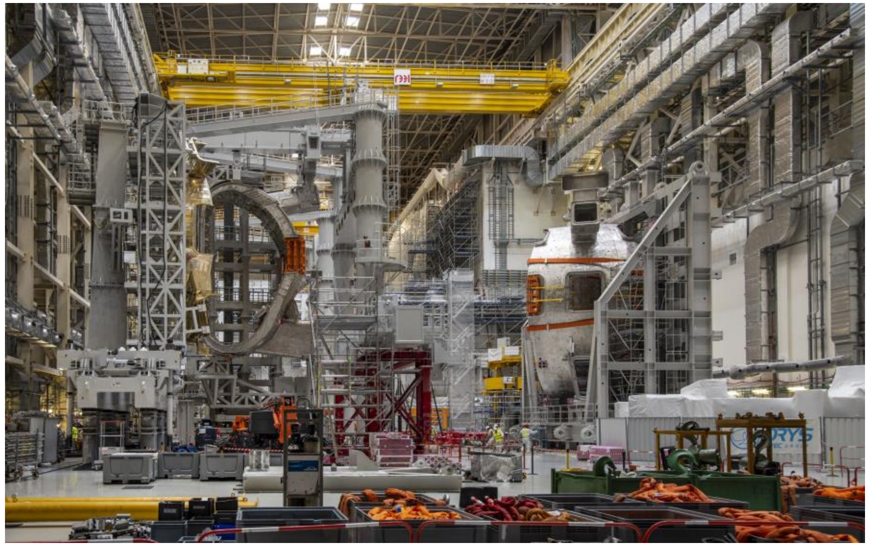
Main elements of the Roadmap revision

Definition of the DEMO step

Gaps to be addressed

Measures to accelerate the DEMO and FPP programs

These points are in addition to the specific activities for the ITER project, which remain central



Definition of the DEMO step – high level goals

Demonstrate performance and integration of key technologies with tolerable failure rates to achieve adequate levels of availability

- Blanket radiation exposure ~20dpa in phase 1 (~6-7y), needed for qualification
- Self-sufficient fuel (tritium) cycle
- Demonstration of intrinsic safety and tolerable impact of waste
- Maintenance systems that ensure plant availability and accessibility
- Net electricity output to grid ~300-500MW (for ~hours)

Tokamak configuration (conceptual design is being developed at EUROfusion)

Target: start operations / commissioning ~20 years after kick off

Qualification of components: DEMO Phase 1 or a Volumetric Neutron Source ?

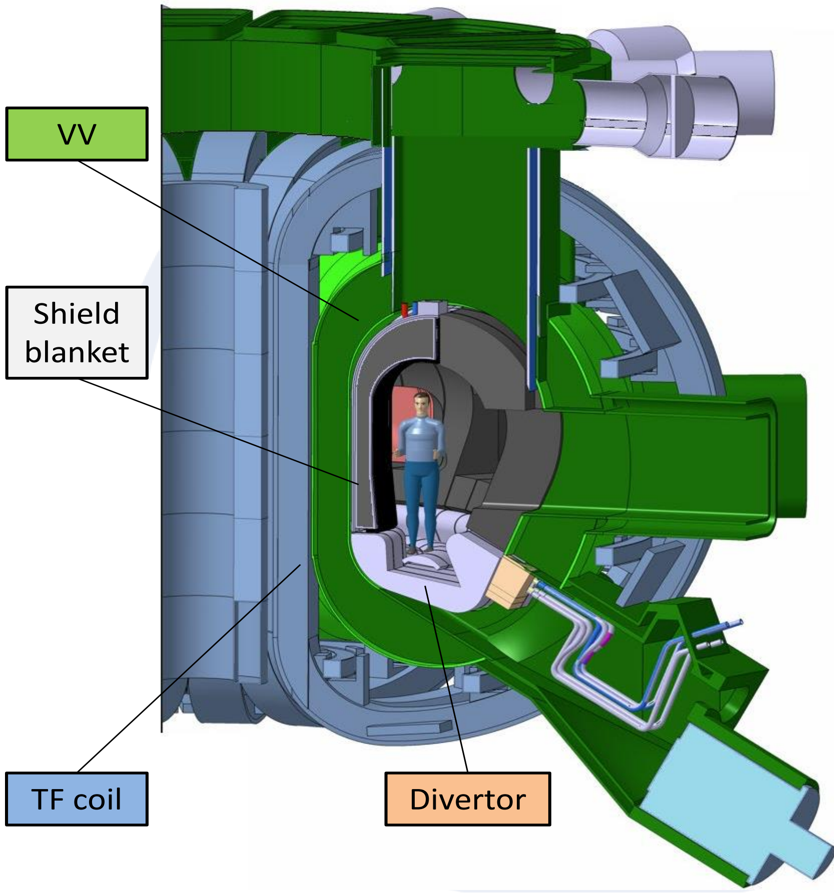
DEMO - Phase 1 may need too long a time to produce enough neutrons to qualify components

It could be more efficient and less risky to have new facility/ies to validate the blanket and the complete fuel cycle, such as a tokamak-based VNS

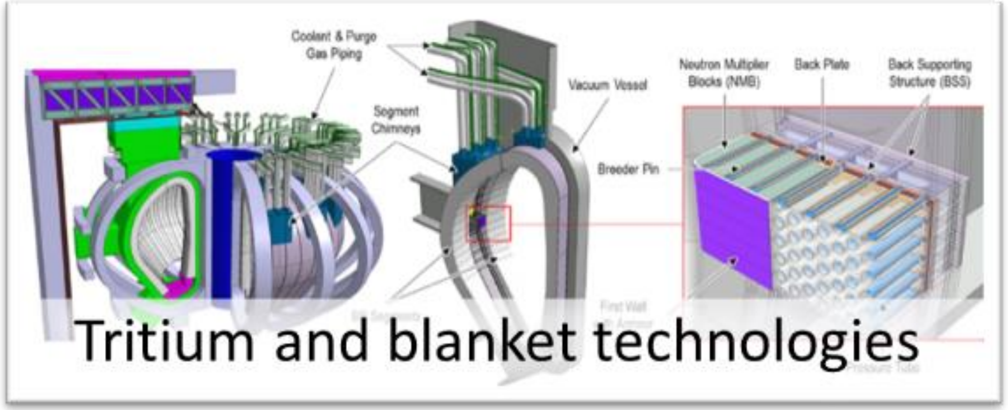
The VNS would produce 14MeV neutrons from beam-plasma DT reactions, with Neutron Wall Loading ≥0.5 MW/m^2

A feasibility study is under way

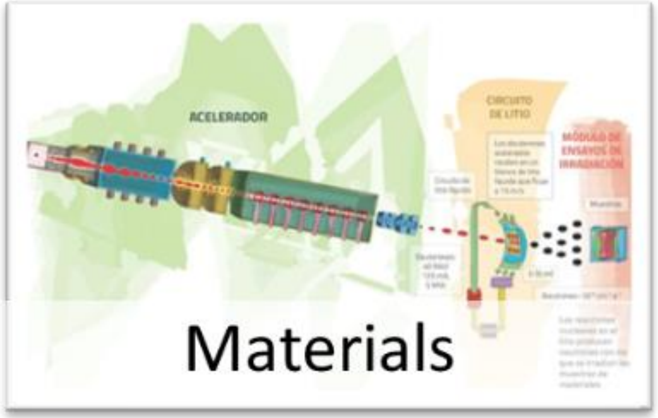
R = 2.53m, B_0 = 5.4 T	
A=4.6	High aspect ratio to create space on the inboard side while minimising the surface
CS	Nb_3Sn, sized to ramp up the plasma, I_p = 1.76 MA
TF coil	Nb_3Sn, B_{max} =12.8 T – trading-off B with TFC size
n-shield (inboard)	Comparable to ITER
P_{fus}	29 MW



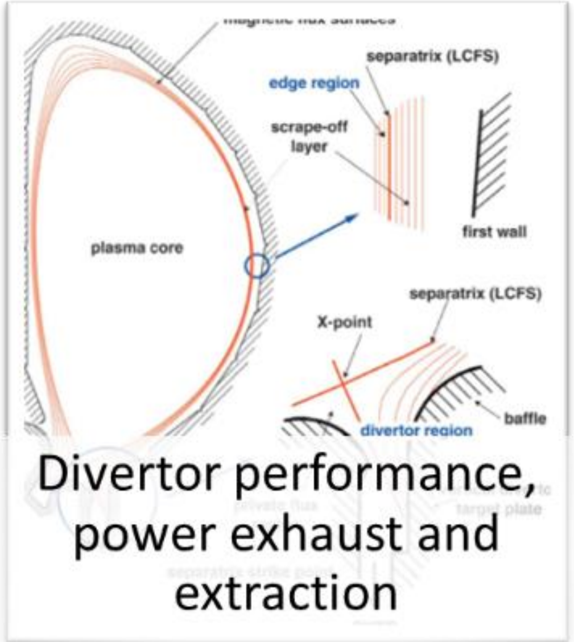
Gaps to be addressed



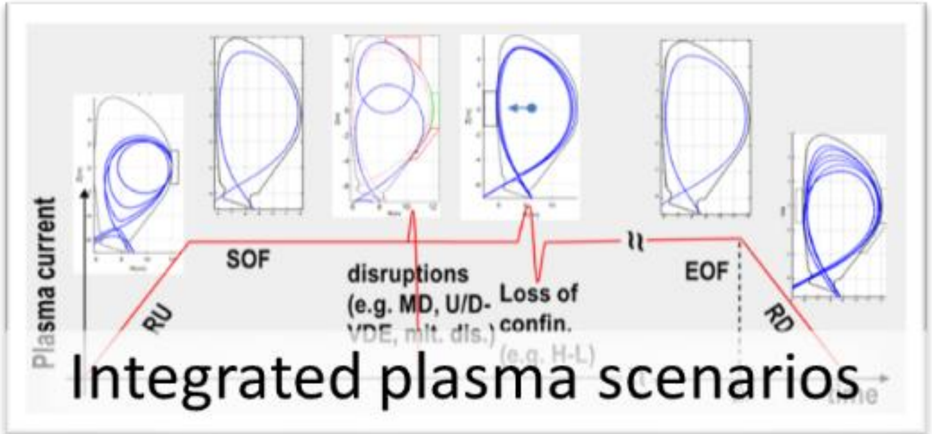
Tritium and blanket technologies



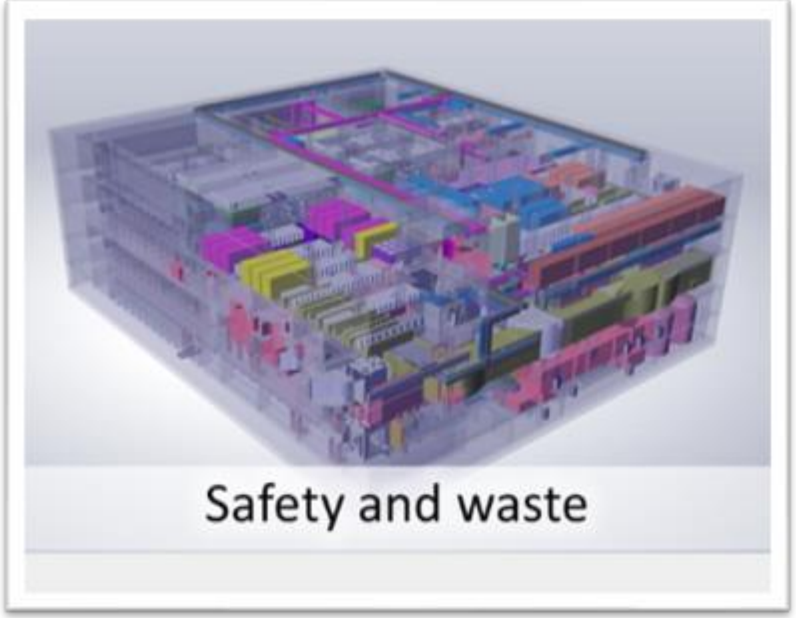
Materials



Divertor performance, power exhaust and extraction



Integrated plasma scenarios

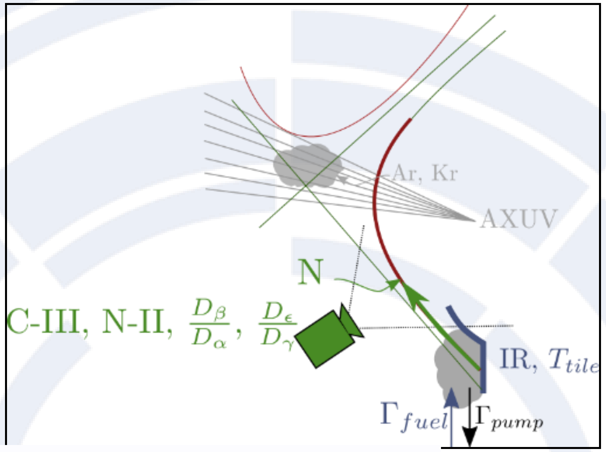

Safety and waste

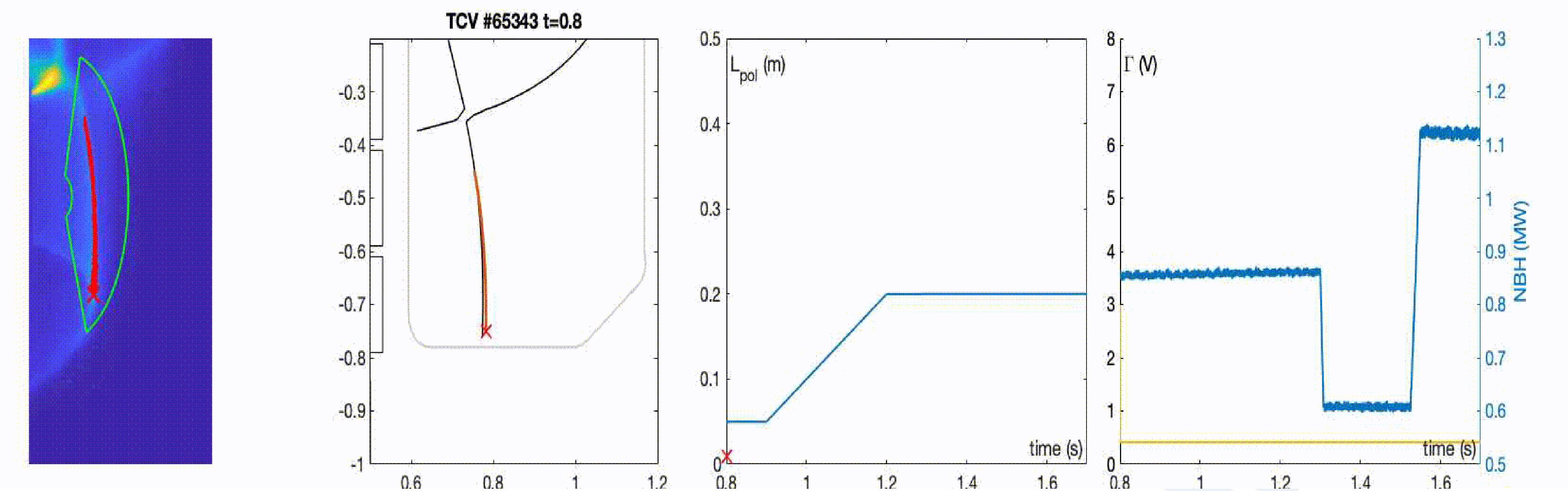

Remote maintenance

A single example of R&D on plasma exhaust, with collaboration and spin-off potential: divertor detachment control

System identification applied to characterize dynamic behaviour on ASDEX-Upgrade, TCV, JET, MAST-U

Ex. real-time control of the C-III emission front in TCV based on MANTIS 10-channel, 400Hz camera





DIFFER

W.A.J. Vijvers *et al* 2017 *JINST* **12** C12058
A. Perek *et al.* Rev. Sci. Instrum. **90** (12) 2019

Measures to accelerate the DEMO program

Strengthening R&D in the identified gap areas

Strong synergy with new ITER Baseline (W-related work), exploitation of JT60-SA

Measures to accelerate the DEMO program

Strengthening R&D in the identified gap areas

Increased effort in simulations for plasma and for engineering

- Digitalization effort, including innovative AI approaches

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Strengthening R&D in the identified gap areas

Increased effort in simulations for plasma and for engineering

Streamlining licensing towards a regulatory framework for fusion and rapidly identifying site

- Crucial for timing – working group has defined the path

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Development and maintenance of adequate workforce

- Increase connections with EU academic and industrial networks, and diversity at all levels, try to create a ‘post-JET hub’

Measures to accelerate the DEMO program

- Strengthening R&D in the identified gap areas
- Increased effort in simulations for plasma and for engineering
- Streamlining licensing towards a regulatory framework for fusion and rapidly identifying site
- Development and maintenance of adequate workforce
- Mutually beneficial new international collaborations
    - Collaborations with China (CRAFT, EAST, BEST, …), US (SPARC, …) etc., for technology facilities and early DT plasma developments…. and UK

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Knowledge management

- Document lessons learned in the ITER design and developments

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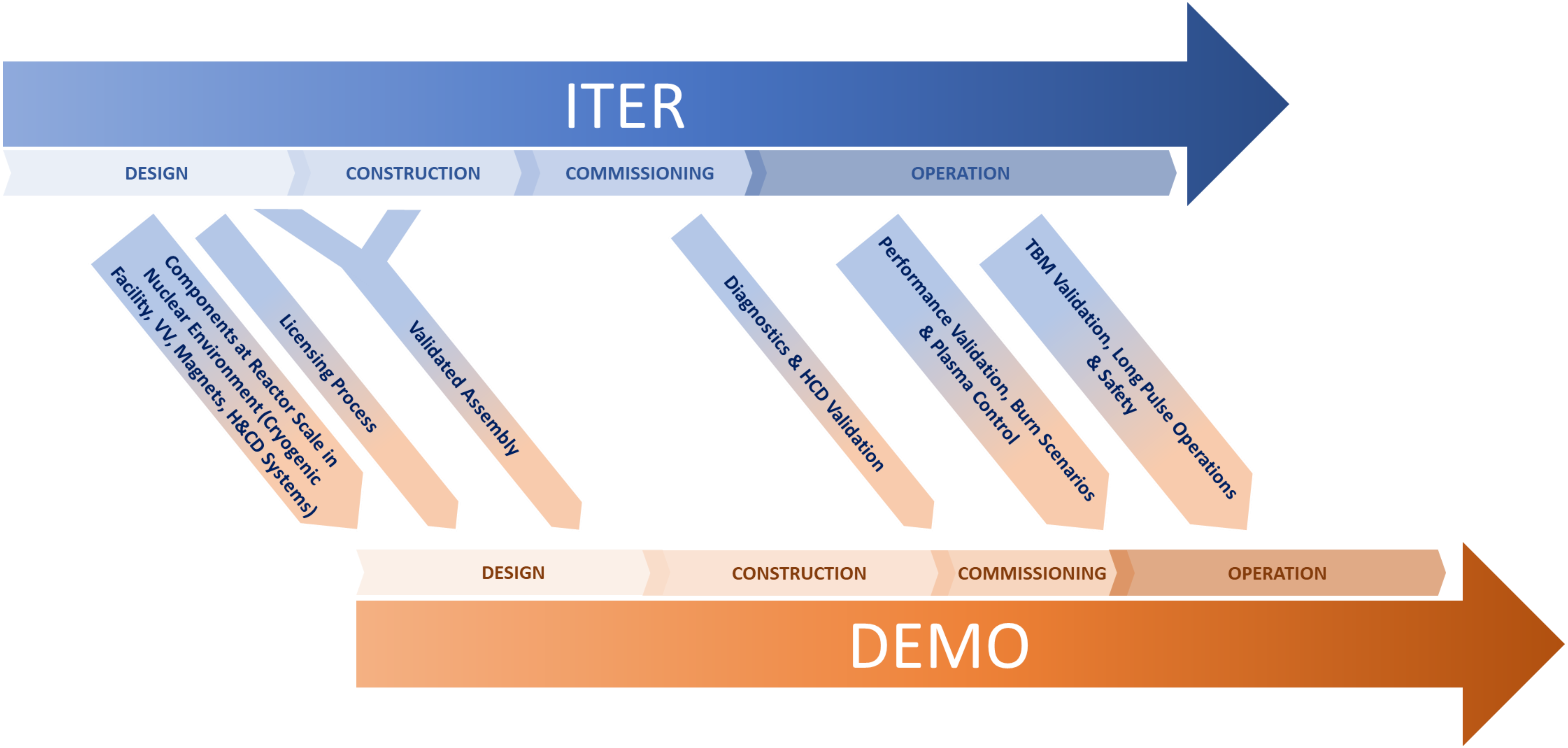
- Knowledge management
- Parallelization of activities to reduce the sequential coupling of ITER milestones and DEMO decision points

Parallelization of ITER and DEMO and the role of ITER



Measures to accelerate the DEMO program

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- Streamlining licensing towards a regulatory framework for fusion and rapidly identifying site
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- Knowledge management
- Parallelization of activities to reduce the sequential coupling of ITER milestones and DEMO decision points
- Public Private Partnerships and involvement of industry

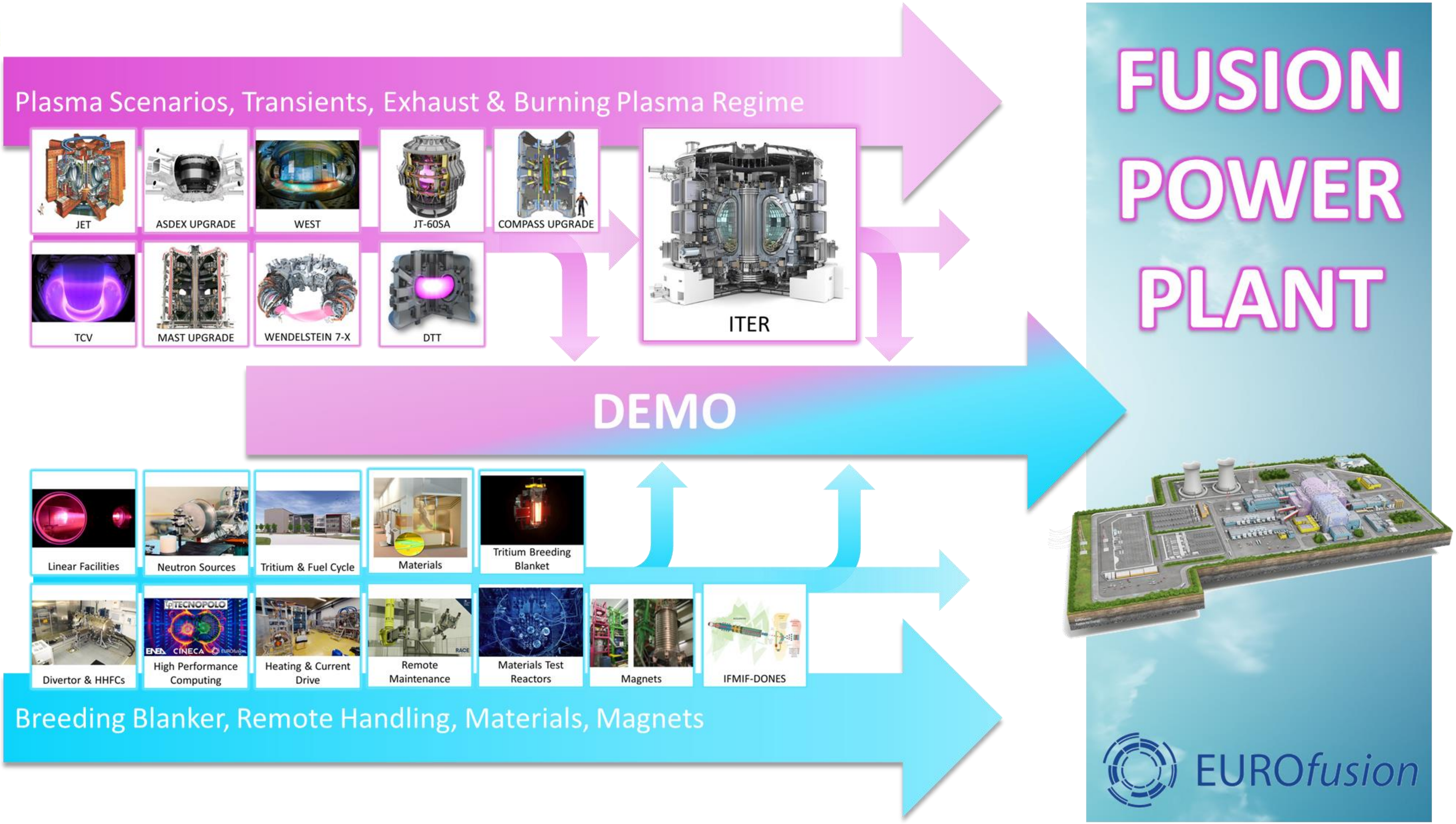
Public-Private Partnerships and involvement of industry

DEMO will be built within an industrial framework, utilizing fully industrial practices

Need to combine industrial and entrepreneurial approaches with the extensive know-how, and the ambitious yet realistic vision of public-funded European fusion program

Collaborative approach involving joint leadership, combination of public and private IP, agile procurement processes compatible with EU industry development, and strategic partnerships

Innovation, industrial view and strategic partnerships are also crucial to address technological gaps prior to DEMO design, and develop capability and capacity in supply chains, especially in areas that are not stimulated by ITER procurement


Plasma Scenarios, Transients, Exhaust & Burning Plasma Regime
JET
ASDEX UPGRADE
WEST
JT-60SA
COMPASS UPGRADE
TCV
MAST UPGRADE
WENDELSTEIN 7-X
DTT
ITER
DEMO
Linear Facilities
Neutron Sources
Tritium & Fuel Cycle
Materials
Tritium Breeding Blanket
Divertor & HHFCs
High Performance Computing
Heating & Current Drive
Remote Maintenance
Materials Test Reactors
Magnets
IFMIF-DONES
Breeding Blanker, Remote Handling, Materials, Magnets
FUSION POWER PLANT
EUROfusion

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