



Digital Solutions for Fusion

Physics Project Board | October 27th, 2025

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(with F. Jenko, V. Naulin, and R. Kamendje)

Thanks to contributions by the E-TASC SB, EnR-IFE SB, EnR-MAT SB, EnR-TEC SB



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Objectives for DSD

1. Leverage Advanced Digital Technologies

- Apply cutting-edge digital tools (AI, ML, digital twins) across all fusion activities.
- Enable comprehensive, integrated simulations (plasma, external systems, control actuators, interfaces).

2. Strengthen Foundation for Future Fusion Facilities

- Enhance design, predictions, and optimization of ITER & DEMO.
- Bridge gaps in fusion research through reliable, first-principles simulations.
- Support plant safety and operational confidence through advanced digital methods.

3. Centralize Digital Expertise

- Consolidate digital activities currently scattered across work packages and departments.
- Establish a common point of reference to harness expertise from different areas.



Activities implemented under DSD in 2025

Bridge knowledge gaps by ensuring reliable, validated digital models, to leverage rapidly advancing digital technologies (AI, ML, Digital Twins) for fusion

Code Development through the set of 15 TSVVs (*Theory Simulation Verification and Validation projects*)

- Develop, maintain, and optimize EUROfusion codebase, ensuring professional structure and validation
- Introduce new functionalities and optimize performance

Tools for Predictive Modelling

- Integrate codes for simulating machines like ITER and future fusion devices,
- Including divertor and engineering sub-systems
- Provide training for end-users

Infrastructure & support activities

- Provide computational resources (HPC, Gateway, LTDSF)
- Assist research software development with teams of computer experts (ACHs)
- Implement standardized data storage and tools

Develop advanced tools and theory models

- Develop fusion-specific AI/ML tools and models
- Stimulate fundamental research, generate theoretical insights (EnRs)



Implementation pattern in 2025

WPAC-Advanced computing					WPEEnR-Enabling research			
ACH - Advanced Computing Hubs	DATA - Data maintenance and management activities	DTE - Digital Twin Environment and Advanced Numerical Methods	HPC - High Performance Computer	TSVV - Theory, Simulation, Verification and Validation	IFE – Inertial Fusion Energy	MAT - Materials	MOD – Theory & Modelling	TEC – Technology & systems
5 projects	2 projects	7 projects	3 projects	15 projects	2 projects	5 projects	4 projects	5 Projects

Scientific programme:

- Long-term (TSVVs, implementation of HPC, GW, LTDSF)
- Mid-Term (EnRs)
- Short-Term (utilization of ACH support and HPC resources)

Management of activities:

Managed by **PMU**:

- No PL/TFL

Scientific Boards:

- E-TASC SB (ACH, DTE, TSVV, EnR-MOD)
- EnR-IFE SB
- EnR-MAT SB
- EnR-TEC SB

Committees:

- HPC OC, HPC PC, HPC AC



Transition to 2026-2027, Digital Solutions for Fusion Office (DSO)

The DSO will drive and coordinate EUROfusion digital innovation activities, including the provision and management of computational and data storage resources. It will support the development of research and engineering software, with a focus on integrating computational tools into a common environment. The DSO will provide digital services tailored to the specific needs of other work packages and departments.



Digital Twin Environment

will focus on enhancing predictive accuracy, real-time feedback, coupled physics-engineering simulation and analysis tools for next-generation facilities.



Advanced Computing Hubs

will focus on providing support to code developers on:

- High-Performance Computing;
- Modelling Frameworks and Standardized Workflows.



Data Management

will focus on unifying access to experimental data following FAIR principles. It will also support further development and maintenance of existing multi-machine databases.

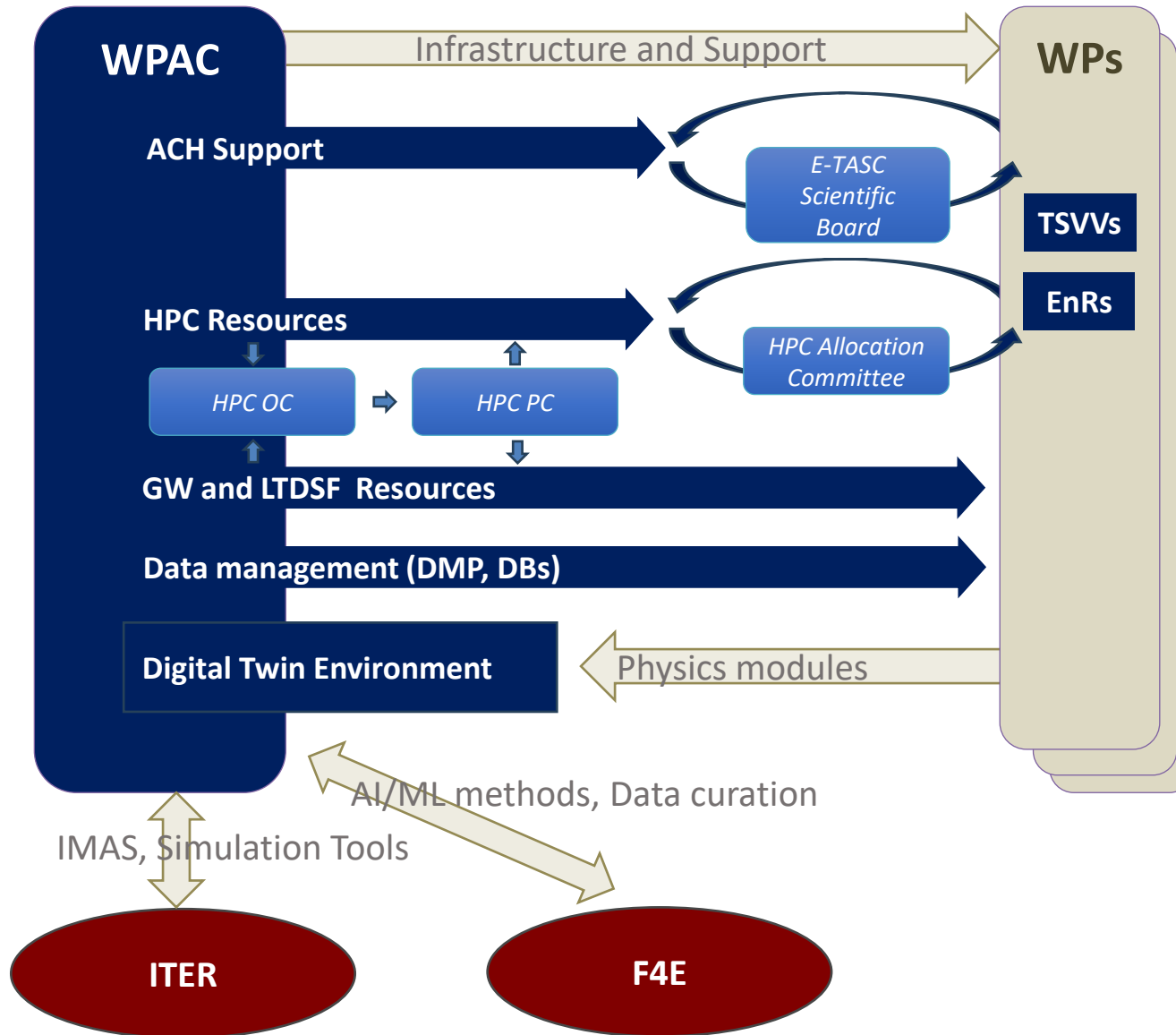


Computational and Data Storage resources

will focus on management and distribution of dedicated computing resources (HPC, GW, LTDSF systems).



Processes and links to stakeholders



Computational Infrastructure and Support to EUROfusion community: *Enables the development, deployment and exploitation of advanced computational tools across all WPs.*

Standardized Data access (FAIR-compatible): *available for all MST devices as well as JET, ensuring transparency, reproducibility, and interoperability across systems.*

Development of a Digital Twin Environment: *leveraging the latest advancements from relevant WPs and TSVVs, integrating state-of-the-art numerical techniques (including artificial intelligence and machine learning) to enhance predictive modelling and simulation capabilities.*

Liaison to ITER and F4E: *ensuring their effective engagement in the planning, implementation, and exploitation of software development activities (focus: IMAS, DTE, AI/ML utilization).*



Current DSD tasks

Monitoring, Review and Reporting on 2025 activities

- EUROfusion Science meeting – Final Report of TSVV projects, 14 and 28 Jan. 2026
https://indico.euro-fusion.org/e/TSVV_Final_Report_1
https://indico.euro-fusion.org/e/TSVV_Final_Report_2
- EUROfusion Science meeting – Final Report of EnR projects (2nd round), 24-25 Nov. 2025
https://indico.euro-fusion.org/e/EnR_Final_Report

Planning of 2026-2027

- Evaluation and selection of proposals

Reference No.	Title	Due Date
CfP-FSD-AWP26-AC-01	Advanced Computing Hubs	6/20/2025
CfP-FSD-AWP26-AC-02	Proposals: Development of a Digital Twin Environment for Fusion Reactor Modelling	9/19/2025
CfP-FSD-AWP26-ENR-03	Enabling Research Proposals in the area of Inertial Fusion Energy (EnR-IFE) for the period of 2026-2027	10/10/2025
CfP-FSD-AWP26-ENR-04	Enabling Research Proposals in the area of Materials (EnR-MAT) for the period of 2026-2027	9/26/2025
CfP-FSD-AWP26-ENR-05	Enabling Research Proposals in the area of Theory and Modelling (EnR-MOD) for the period of 2026-2027	9/26/2025
CfP-FSD-AWP26-ENR-06	Enabling Research Proposals in the area of Technology and Systems (EnR-TEC) for the period of 2026-2027	9/26/2025
CfP-FSD-AWP26-TM-07	Project Proposals for Theory, Simulation, Verification and Validation (TSVV) Activities	9/19/2025
CfP-FSD-AWP26-AC-08	Participation in EUROfusion Coordinated Data Management activities	9/26/2025
CfP-FSD-AWP26-AC-12	Proposals for the use of the EUROfusion High Performance Computer (10th cycle)	11/17/2025
GF/DK-25-98	Tasks to be carried by Advanced Computing Hubs in 2026	11/21/2025



Renewal of Scientific Boards

Following Boards will be active during 2026-2027:

SB EnR-IFE	SB EnR-MAT	SB EnR-TEC	SB E-TASC
Jacquemot Sylvie (CEA)	Barthe Marie-France (CEA)	Stéphane Heuraux (04-UL)	José Luis Velasco (CIEMAT)
Volpe Luca (CIEMAT)	Teresa Hernandez (CIEMAT)	Iván Fernández Berceruelo (CIEMAT)	Fulvio Zonca (ENEA)
Krus Miroslav (IPP.CR)	Davide Bernardi (ENEA)	Søren Bang Korsholm (DTU)	David Tskhakaya (IPP.CR)
Michael Tatarakis (NCSRD)	Unterberg Bernhard (FZJ)	Giuseppe Mazzone (ENEA)	Rui Coelho (IST)
Mattia Cipriani (ENEA)	Eugene Kotomin (ISSP-UL)	Wolfgang Biel (FZJ)	Colin Roach (UKAEA)
Piotr Rączka (IPPLM)	Garkusha Igor (KIPT)	Jakub Bielecki (07-IFJ PAN)	Francesca Rapetti (CEA)
	Terentyev Dmitry (01-SCK-CEN)	Igor Girka (KIPT)	Egbert Westerhof (DIFFER)
	Nordlund Kai (VTT)	Manfred Thumm (KIT)	Stephan Brunner (EPFL)
		Ulrich Stroth (MPG)	Yannis Kominis (NCSRD)
		Konstantina Mergia (NCSRD)	Aaro Jarvinen (VTT)
			Frank Jenko (MPG)
			Xavier Litaudon (CEA)

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Updates to HPC Operation, Project and Allocation Committees

HPC OC, HPC PC

R. Kamendje handed over the chairmanship of the HPC OC (done during the OC meeting in August 2025) and the secretaryship of the HPC PC (done during HPC PC in Sept 2025) to D. Kalupin

HPC AC

Name	Institution	Area of expertise	Country
Anders Henry Nielsen	DTU	Edge physics, Integrated modelling of fusion plasmas,	Denmark
Nicola Vianello	ENEA	Linear, Nonlinear and/or Extended MHD	Italy
Eric Sonnendrucker	IPP	Plasma Turbulence and related transport processes, Fast particle physics, Linear, Nonlinear and/or Extended MHD, Edge physics, Heating and Current Drive,	Germany
Maria Caturla	Uni. Alicante	Reactor materials,	Spain
Daniel Gallart	BSC	Fast particle physics, Heating and Current Drive,	Spain
Paolo Ricci	SPC (EPFL)	Plasma Turbulence and related transport processes, Linear, Nonlinear and/or Extended MHD, Edge physics,	Switzerland
Andrea Sand	VTT	Reactor materials, Reactor technology,	Finland
Sergei Dudarev	UKAEA	Reactor materials, Reactor technology,	UK
Christos Tantos	KIT	Integrated modelling of fusion plasmas, Reactor materials, Reactor technology,	Germany
David Tskhakaya	IPP-CR	Plasma Turbulence and related transport processes,	Czechia
Yves Ferro	CEA	Reactor materials, Reactor technology,	France
Yanick Sarazin	CEA	Plasma Turbulence and related transport processes, Fast particle physics, Edge physics,	France