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WP STELLARATOR 2026-2027

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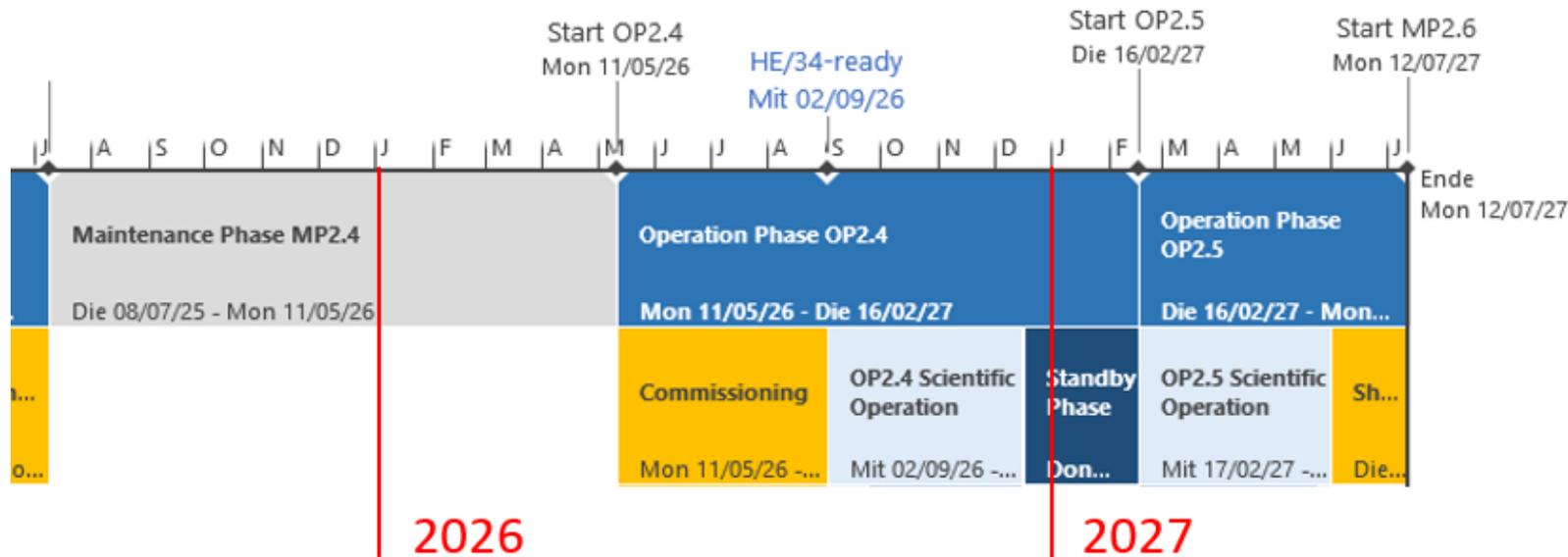
High-level objectives of WPSTEL in 2026–2027

- WPSTEL covers the EUROfusion contribution to the exploitation of Wendelstein 7-X and stellarator reactor studies.
- *Overarching goal:* Provide a physics and technology basis for the assessment of stellarators as reactor candidates.

High-level objectives for 2026–2027, grouped into **three main areas, A1, A2 and A3.**

A1. Preparation, execution and exploitation of W7-X campaigns in 2026–2027

- Long pulse, high-performance scenarios based on profile control at reactor-relevant v and β .
- Assessment of the optimization of the magnetic configuration at reactor relevant parameters on: fast particle behavior, MHD equilibrium and stability, etc.





High-level objectives of WPSTEL in 2026–2027

A2. Assessment on physics gaps for the development of stellarator reactors in preparation of FP10

- Identification and analysis of key physics uncertainties between present-day stellarators and a future reactor.
- Determination of which ones can be addressed within WPSTEL, and develop recommendations.

A3. Stellarator reactor studies

- Identify and further analyse a small set of the most advanced next-generation optimised stellarator configurations and associated coil designs, in close coordination with engineering studies.
- Adapt and assess blanket concepts for 3D stellarator geometries.
- Outline remote maintenance needs and constraints for stellarator reactors.



Structure of WP W7X

Exploitation of W7-X*

ITER, Enhancements

Campaign participation incl. missions in 2026 and 2027

Diagnostic systems for ITER

Preparation of the campaign in 2026 and 2027

High power gyrotrons

Exploitation of W7-X aligned with Grand Deliverables

Large diagnostic projects: MATEO, sFILD





Structure of WP STEL

Exploitation of W7-X

Campaign participation incl. missions in 2026 and 2027

Preparation of the campaign in 2026 and 2027

Exploitation of W7-X aligned with Grand Deliverables

Key Physics Gaps

Continue work of expert group (EPS talk, paper)

Address high priority key physics gaps

HELIAS physics basis and stellarator database

ITER, Enhancements

Diagnostic systems for ITER

High power gyrotrons

Large diagnostic projects: MATEO, sFILD

Stellarator DEMO

Coil design for advanced configurations

Neutronic calculations and tools for neutronic analysis

Development of 3D blanket structures



Objectives of WP STEL

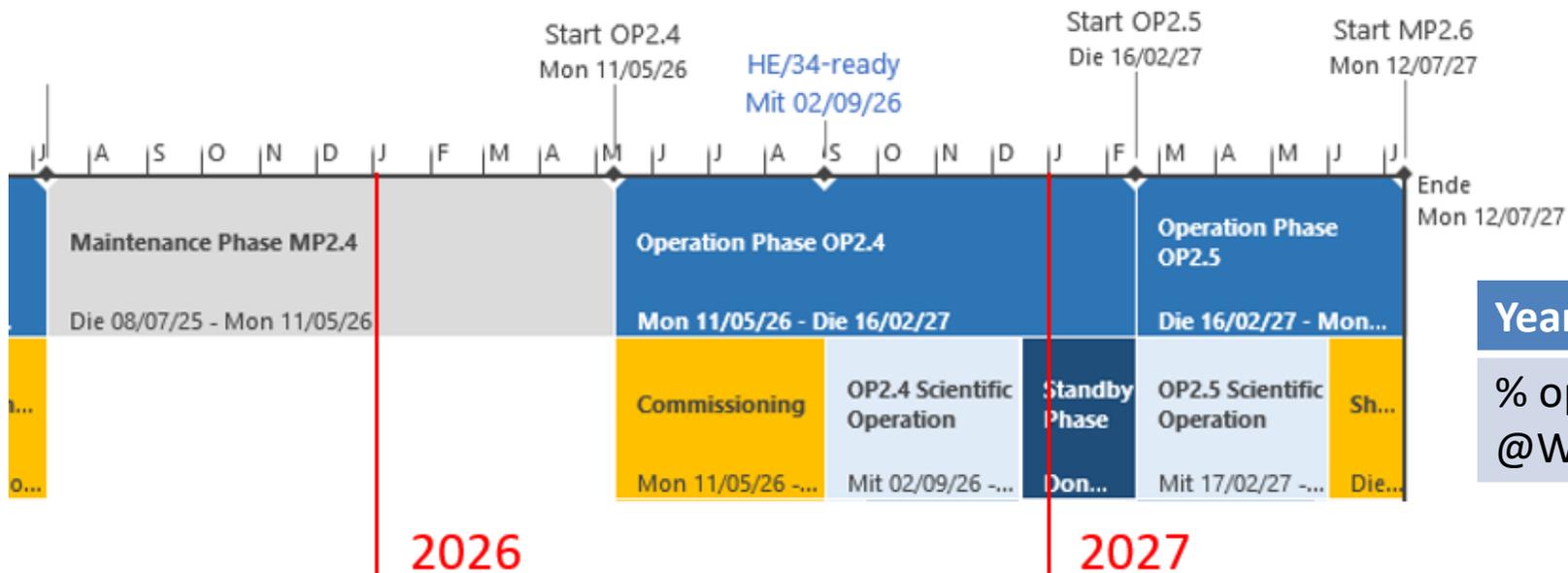
WPSTEL-2026/2027.01

Conduct and support the 2026/2027 campaigns of W7-X

The campaigns in 2026 and 2027 will be implemented involving the responses to the 2026/2027 WPW7X Call for Participation.

WPSTEL-2026/2027.02

Carry out the development of the diagnostics (spectroscopy systems, reflectometry, video, probes, endoscopes) as a preparation of the campaign.



Years	2026	2027
% operationl time @W7X	30%	27.5



Objectives of WP STEL (continued)

WPSTEL-2026/2027.O3	Analyse and model campaign results. Use other facilities (TJ-II, Uragan-2M) to validate scenarios and tools that can be applied to W7-X
WPSTEL-2026/2027.O4	Address HELIAS physics gaps
WPSTEL-2026/2027.O5	Carry out the development of the system enhancements and ITER support.
WPSTEL-2026/2027.O6	Ensure information exchange with WPDIV, WPPWIE, WPTE and continue international collaborations in support of the Mission 8 objectives. Prepare IMAS database of the stellarator data.
WPSTEL-2026/2027.O7*	Collaboration with TSVV-I on stellarator optimization and lay out plans with the goal of producing next-generation optimized configurations that can be the basis of reactor designs.
WPSTEL-2026/2027.O8*	Collaboration with TSVV-J in order to enhance the capabilities of micro-turbulence modelling in W7-X via development of the currently available gyrokinetic codes, their verification and their application to specific transport problems.
WPSTEL-2026/2027.O9	Carry on developments for Stellarator Power Plant Studies as indicated below.



Resource allocation summary AWP26-27

WBS ID	Sub-project	Manpower [PM]	E&GS (incl. use of facilities) [k€]	Missions (actual) [k€]	CC resources [k€]	Total resources [k€]	Related GD/GM
STEL-1	Project Management	28.8	-	325	462	661	
STEL-2	Exploitation of W7-X: GDs + campaign	423 (incl. 50 NA, 22 AR)	-	-	1101	2307	GD1-3
STEL-3	Machine Operation (W7-X)	469.8	4496	-	8324	10406	
STEL-4	HELIAS key physics gaps	76 (incl. 7 AR)	-	-	244	521	
STEL-5	ITER, Enhancements	204	-	-	881	1762	GD1-3
STEL-6	Stellarator DEMO reactor	58	-	-	206	412	
2026 Total		789.8 (+469.8)	(4496)	325	11218	16068	
STEL-1	Project Management	28.8	-	325	465	664	
STEL-2	Exploitation of W7-X: GDs + campaign	423 (incl. 50 NA, 22 AR)	-	-	1106	2320	GD1-3
STEL-3	Machine Operation	424.5	4120	-	7633	9541	
STEL-4	HELIAS key physics gaps	68	-	-	244	488	
STEL-5	ITER, Enhancements	157	-	-	678	1357	GD1-3
STEL-6	Stellarator DEMO reactor	58	-	-	209	418	
2027 Total		734.8 (+424.5)	(4120)	325	10335	14788	



W7-X Exploitation aligned with Grand Deliverables for 2026/2027

ID	Deliverables Table	Gap to be addressed	Priority	PM 2026	PM 2027
STEL. D.01	High confinement scenarios via plasma profile control and high power scenarios at low magnetic field to reach reactor relevant collisionalities ($\nu^* < 0.1$) and high beta ($\langle \beta \rangle \geq 2.5\%$)	(1) Experimental validation of fast ion optimization at high beta discharges. (2) Experimental validation of numerical modelling of the influence of high beta on heat and particle exhaust channels	high	115,5	118
STEL. D.02	Experimentally assessed modelling predictions for fast ion physics and turbulent transport	Validate numerical tools developed to predict fast ion physics and turbulent transport	medium	86	108
STEL. D.03	Long pulse scenarios with $n\tau_i > 0.1e20$ and plasma duration of up to 1000 s	Access to stable, high radiation regimes without decrease in core performance	high	150,5	133



Assignment of financial resources 2026

Tag	Beneficiary	PMs	Cons. Contr. (CC)	
TFL/PSO	MPG	16.8	120	
DTFLs	CIEMAT	12	58	
OP2.4 campaign at W7-X	Not allocated	50	213	
Missions inside/outside campaign	Partially allocated		284	
Activities to achieve GD 1	IPPLM, CIEMAT, EK-CER, FZJ, IST, ENEA, KIPT, EPFL, OEAW, LPP-ERM-KMS	115,5	344	874 k€
Activities to achieve GD 2	IPP.CR, CIEMAT, EK-CER, FZJ, LPP-ERM-KMS, ENEA, KIPT, VTT, EPFL, NCSR, D,	86	236,5	
Activities to achieve GD 3	ENEA, IPPLM, KIPT, CEA, EK-CER, FZJ	150,5	294	
HELIAS physics gaps	CIEMAT, MPG, FZJ, KIT, NCSR, D	50	209	
ITER, Enhancements	ENEA, KIT, CIEMAT, DTU	204	881	
Stellarator Reactor Technology	MPG, CIEMAT, UKAEA, EPFL, KIT, ENEA, OEAW	62	234	
Total:			2874	



Assignment of financial resources 2027

Tag	Beneficiary	PMs	Cons. Contr. (CC)
TFL/PSO	MPG	16.8	120
DTFLs	CIEMAT	12	58
OP2.4 campaign at W7-X	Not allocated	50	214
Missions inside/outside campaign	Not allocated		284
Activities to achieve GD 1	IPPLM, CIEMAT, EK-CER, FZJ, IST, ENEA, KIPT, EPFL, OEAW, LPP-ERM-KMS	118	285
Activities to achieve GD 2	IPP.CR, CIEMAT, EK-CER, FZJ, LPP-ERM-KMS, ENEA, KIPT, VTT, EPFL, NCSR, D,	108	313
Activities to achieve GD 3	ENEA, IPPLM, KIPT, CEA, EK-CER, FZJ	133	314
HELIAS physics gaps	CIEMAT, MPG, FZJ, KIT, NCSR, D	57	214
ITER, Enhancements	ENEA, KIT, CIEMAT, DTU	157	678
Stellarator Reactor Technology	MPG, CIEMAT, UKAEA, EPFL, KIT, ENEA, OEAW	58	209
Total:			2689

912 k€



ITER, Enhancements

Activity	BEN	PM (2026)	PM (2027)
2 MW gyrotron: Resonator	ENEA	16	8
2 MW gyrotron: Exp Testing	KIT	40	18
2 MW gyrotron: MultiPhys	NCSR	20	10
MATEO	FZJ	70	55
sFILD diagnostics	CIEMAT	40	48
Dual Thomson Scattering	ENEA	2	2
CTS system upgrade	DTU	12	12



HELIAS Key Physics Gaps (56 PM – CC 209k€)

Activity	PM (2026/2027)	BEN
Experts on Key Physics Gaps	12	MPG, CIEMAT, FZJ
HELIAS Physics at TJ-II	38	CIEMAT
Improving exhaust of island divertor	6	KIT, NCSR



Stellarator DEMO reactor activities in 2026/2027 (58 PM)

- The budget made available by the PMU in April increased from €134k to €234k by reassigning internal resources, this is an important area of research.
- Two coordinators were appointed to improve the streamlining of task definition and monitoring.
- **Many activities are continuation from 2021-2025. GD report postponed from 31.12.2025 to 30.06.2026**

Activity	PM	BEN
Expert on development of stellarator reactor: Coordinator (Iole Palermo)	2	CIEMAT
Expert on development of stellarator reactor: Coordinator (Felix Warmer)	2	MPG
Remote maintenance in a stellarator: strategy, key requirements for breeding blanket	10	UKAEA CIEMAT
3D blanket for a stellarator reactor	16	ENEA KIT CIEMAT
Neutronics, Monte Carlo Simulations, high and low fidelity modelling	30	CIEMAT, KIT, VTT, DIFFER, UKAEA
Advanced configurations: Physically accurate heat load patterns for arbitrary wall geometry and general magnetic field topology	2	OEA



WPSTEL - 2027 budget requests and priorities

Topic	Required resources (PM, hardware, facilities, ...)	Associated CC budget* [k€]	Associated EC budget* [k€]	WP priority (Low, Medium, High)	PSD priority TBD
Extension of PNBI from 4 to 6 sources to reach Ptotal > 20 MW	24 PM	102	113	high	
Stellarator reactor: Remote handling in 3D environment of FOAK	12 PM	51	56	high	
Stellarator reactor: Preparation of design space using system studies for FOAK stellarator	6 PM	26	28	high	
Stellarator reactor: Mechanical stress analysis of 3D inter-coil support towards FOAK	12 PM	51	56	medium	
Stellarator reactor: Initial assessment of a FOAK particle exhaust and fuel cycle	6 PM	26	28	medium	
Stellarator reactor: Transfer of novel technologies towards 3D first wall and blanket	6 PM	26	28	medium	



PCR: Extension of NBI from 8 MW to 12 MW Prio: high)

- In order to achieve $\langle\beta\rangle$ of 4% W7-X needs to achieve W_{dia} of ca. 2 MJ.
- This can be achieved at lower magnetic field with heating power of ca. 20-30 MW.
- NBI enables direct ion heating, whereas ECRH heats ions only indirectly via electrons.
- Presently, the available input power is:
 - PECRH up to 8.5 MW \rightarrow will be increased to 12 MW
 - PNBI up to 8 MW \rightarrow may be increased to 12 MW
 - PICRH up to 1 MW \rightarrow still in exploratory phase
- Enhancement of PNBI essential for achieving the goals of W7-X, possible at the beginning of FP10.

