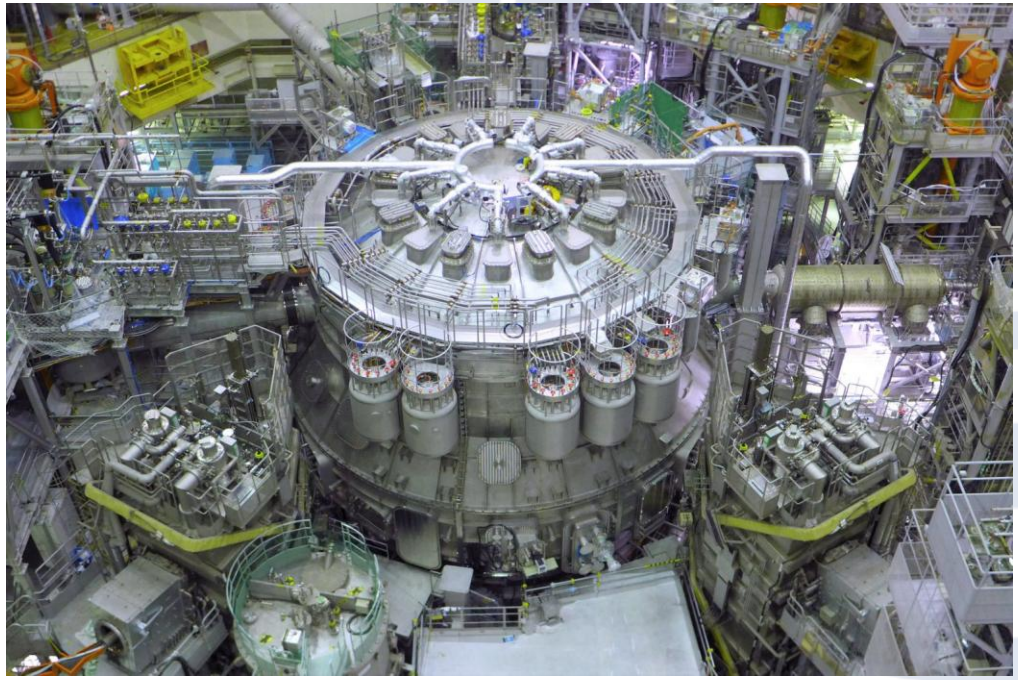
FSD Project Board 05 November 2026

Enhancement and Commissioning of JT-60SA (WPSA) Plans for 2027

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This work has been carried out within the framework of the EUROfusion Consortium, funded by the European Union via the Euratom Research and Training Programme (Grant Agreement No 101052200 — EUROfusion). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.

Background

Timeline for OP2 campaign and cycle planning

- **Integrated commissioning with plasma:** January – February 2027
- **Starting plasma conditions for OP2 exps.:** I_p = 1MA; P-NBI(H) ~ 6MW, Δt ~ 3-5s; ECRF ~ 3MW (4 gyrotrons); N-NBI(H): Δt ~ 0.5s

Tentative start of OP2 experiments: 09/03

	Cycle #1 (~March 2027)	Cycle #2 (~April 2027)	Cycle #3 (~May 2027)	Cycle #4 (~June 2027)
	Hydrogen plasma	**H → D changeover**	**Deuterium plasma** ($I_p \leq$ 3MA)	**Deuterium plasma** (high current, $I_p >$ 3MA)
Main gas fuelling	H_2	H_2 (1 week; no-NBI); D_2 (3 weeks)	D_2	D_2
P-NBI	H	D	D	D
N-NBI	H	H	H	**Two options: D or H** (see later)

OP2 project milestones

- **Shine-through**
- **Error-field studies**
- **H-mode (I_p < 3MA)**
- **20kA CS test**
- **High-I_p >3MA (H-mode and L-mode)**

July => ? ME2

Start of OP3 tbd (2028?)

Background: presently ongoing hw enhancements

System under procurement or development	Reference person	Proposed Op.	Present status
FILD	Juan Ayllon, Lina Velarde (CIEMAT, U. Sevilla)	OP3	In-vessel components ready for procurement. Ex vessel design nearly finalized for procurement
TPCI	Stefano Coda (EPFL)	OP3	Components to be installed in ME-1 delivered. Finalization of ME3 components and procurement ongoing.
Doppler Reflectometry	Elena de la Luna (CIEMAT)	OP4 tbc	Consolidated concept for the DR system that meets spectral resolution requirements. Pending decision on the final instrumentation location
EC Stray detection system	Saul Garavaglia (ENEA-CNR) + MPG (W7-X team)	tbd	• Al2O3+TiO2 as the primary absorbing material for the bolometer system • robust bolometer design validated through MISTRAL laboratory tests and W7-X operations • sniffer probe design moving into the laboratory testing and calibration
Gamma-ray spectrometer	Massimo Nocente (ENEA, UNIMIB)	OP3	Design phase for the JT-60SA LaBr3(Ce) Gamma-ray Spectrometer completed. Procurement started. Detailed design of the collimator structure ongoing
EU Neutron diagnostics (Vertical Neutron Camera)	Marco Cecconello (VR)+ Lukasz Swiderski (IPPLM)	tbd	Count rate evaluation under the geometrical constraints and in lab detector test ongoing. Extension of the simulation of the measurement scenarios
EU Neutron spectrometer	Davide Rigamonti (ENEA-CNR)	OP4 tbc	Diagnostics components of a LaCl3-based compact spectrometer for 2.5 MeV neutron spectroscopy defined. Expected fluxes at the detector under confirmation Return of experience from MAST-U and EAST installation under consideration
RE monitor	Daniele Marocco (ENEA)	OP3	Physical interfaces and detector performances assessed, Front-end electronics developed - Ready for procurement after DR
Neut. Spectrum Reconst. for Activation foils (F4E)	Katarzyna Mikszuta-Michalik (IPPLM)	OP2	high-intensity part of the JT-60SA neutron spectrum can be reliably reconstructed from activation measurements with an uncertainty below 25%. Tools optimized for application in JT-60SA (irradiation sequence + definition of spectral regions)
Various diagnostics proposals for the W phase (OP4 or later)	various	≥OP4	Initial feasibility completed.

PM resources in 2027 (before SNE)

1.8 Compact Neutron Spectrometer RO	4	2	2
1.9 CNS expert	5	2	3
1.10 Pellet System RO	4	2	2
1.11 Pellet System expert	9	6	3
1.12 Diagnostic system expert	15	10	5
1.13 Diagnostic system RO	4	3	1
1.14 Neutronics expert	12	10	3
2.1 Plasma Operations Area Coordinator	4	2	2
2.2 Thomson Scattering TRO	4	2	2
2.3 Thomson Scattering Expert	9	7	2
2.4 Divertor VUV spectroscopy TRO	3	2	1
2.5 VUV spectroscopy expert	6	5	1
2.6 MGI expert	4	2	2
2.7 EDICAM expert	6	3	3
2.8 Subsystem operation expert	4	1.5	3
3.1 Code Management Area Coordinator	4	2	2
3.2 Pulse Design Simulator expert	6	4	3
3.3 Electron Cyclotron Waves simulation expert	5	2	3
3.4 Magnetic control expert	5	3	3
3.5 Cryo-magnet system simulation and data analysis expert	4	2	2
3.6 Control room monitoring tools/ Synthetic diagnostics expert	6	3	3
		0	0
tot PMs(I) available	149	92.5	60

Indicative resources	cc, k€	PM
Mission budget (cc, k€)	231.875	
PM 50%	238.1067708	60.25
PM SNE	99.43	30

Objectives in 2027

- Edge Thomson Scattering System
  - Exploitation and support to operation in OP2 **=> SNE + remote support**
  - Post-campaign calibration between OP2 and OP3 campaign **=> SNE + WPSA Enhancements**
  - Maintenance and system upgrades (e.g. laser power monitor, real-time development,…) **=> SNE**
  - ***Support to operation in OP3 (on site + remote)***
- Div VUV System
  - Exploitation and support to operation in OP2 **=> SNE + remote support**
  - Post-campaign calibration between OP2 and OP3 campaign **=> SNE + WPSA Enhancements**
  - Maintenance and system upgrades (e.g. endoscope for optical alignment, vacuum system,…) **=> SNE**
  - ***Support to operation in OP3 (on site + remote)***
- EDICAM
  - Support to operation (on site + remote)**=>SNE + remote support**
  - Maintenance and system upgrades (e.g. real-time development) **=> WPSA Enhancements**
- Support plasma commissioning of MGI **=> WPSA Enhancements**
- Installation and commissioning of FILD **=> F4E contract + WPSA Enhancements (?)**
- Installation and commissioning of TPCI **=> F4E contract + WPSA Enhancements (?)**
- Installation and commissioning of $LaBr_3$(Ce) Gamma Spectrometer **=> F4E contract + WPSA Enhancements (?)**
- Installation and commissioning of Runaway Electron Monitor **=> F4E contract + WPSA Enhancements (?)**
- Development of the Pellet Launching System
  - Scientific support to sources development (F4E tender) and integration with the launcher **=> WPSA Enhancements**
  - Integration and laboratory test **=> WPSA Enhancements**
- Procurement and characterization of the $LaCl_3$(Ce) Compact Neutron Spectrometer **=> WPSA Enhancements**
- Finalize the design of Doppler Reflectometry **=> F4E contract + WPSA Enhancements (?)**
- Finalize the design of the Vertical Neutron Camera **=> WPSA Enhancements**
- Support the development of the selected Edge and SOL diagnostics **=> NOT funded at present, some preparatory work (W scenario simulations) in ET/WPTE call**
- Support the development of operational oriented tools (mainly towards Real Time control) **=> WPSA Enhancements + handover to WPTE (campaign)**

Adequate
Marginal
At risk

Grant Milestones and Deliverables

- SA.D.06 *Installation of the EU systems before the OP2 campaign* (due: 31/12/2024; **expected delivery date: 31/07/2026**) – proposed delay to 31 December (after machine pump-down)
  - Comment: **The installation plan is strongly dependent on the schedule of the shutdown for the Machine Enhancement 1 (now ongoing)**

- **02_WPSA GA-Milestone** *Commissioning of the Edge Thomson Scattering diagnostics in JT-60SA completed - Records of commissioning available.* **(due: 31.12.2026 - likely delay according to the start of plasma operation)**

ID	Deliverable Title	Date	Comments
	Report on first measurement of the pedestal density and temperature at sub-cm spatial resolution in JT-60SA	31.12.2027	**Current status of the calibration *might* impact**

Back-up slides

Present 2026-2027 plan (resources, March 2026)

Role Title	PMs X activity	2026	Involved beneficiaries	2027	Involved beneficiaries
1.1 Enhancements Area Coordinator	**4**	**2**	**CIEMAT (US)**	**2**	**CIEMAT (US)**
1.2 Fast Ion Losses Detector RO	4	2	CIEMAT	2	CIEMAT
1.3 Fast Ion Losses Detector expert	4	4	CIEMAT	0	CIEMAT
1.4 Tangential Phase Contrast Imaging RO	2	1	EPFL	1	EPFL
1.5 TPCI expert	4	4	EPFL	0	EPFL
1.6 Gamma Ray Spectrometer RO	4	2	ENEA (UNIMIB)	2	ENEA (UNIMIB)
1.7 GRS expert	4	2	ENEA (CNR), UKAEA	2	ENEA (CNR), UKAEA
1.8 Compact Neutron Spectrometer RO	4	2	ENEA (CNR)	2	ENEA (CNR)
1.9 CNS expert	5	2	ENEA (CNR)	3	ENEA (CNR)
1.10 Pellet System RO	4	2	MPG	2	MPG
1.11 Pellet System expert	9	6	MPG	3	MPG
1.12 Diagnostic system expert	15	10	CIEMAT, ENEA, IPPLM(NCBJ), VR,FZJ,DTU	5	ENEA, IPPLM(NCBJ), VR
1.13 Diagnostic system RO	4	3	CIEMAT	1	CIEMAT
1.14 Neutronics expert	12	10	IPPLM	2	IPPLM
2.1 Plasma Operations Area Coordinator	**4**	**2**	**ENEA**	**2**	**ENEA**
2.2 Thomson Scattering TRO	4	2	ENEA (CRFX)	2	ENEA(CRFX)
2.3 Thomson Scattering Expert	9	7	IAP(ICIT), ENEA (CRFX)	2	ENEA (CRFX)
2.4 Divertor VUV spectroscopy TRO	3	2	ENEA (CRFX)	1	ENEA (CRFX)
2.5 VUV spectroscopy expert	6	5	IAP(ICIT), ENEA (CRFX)	1	ENEA (CRFX)
2.6 MGI expert	4	2	MPG	2	MPG
2.7 EDICAM expert	6	3	EK-CER	3	EK-CER
2.8 Subsystem operation expert	4	1.5	CEA	2.5	CEA, ENEA
3.1 Code Management Area Coordinator	**4**	**2**	**CEA**	**2**	**CEA**
3.2 Pulse Design Simulator expert	6	4	CEA, ENEA(CREATE)	2	CEA, ENEA(CREATE)
3.3 Electron Cyclotron Waves simulation expert	5	2	ENEA(CNR), NCSRD	3	ENEA(CNR), NCSRD, CR
3.4 Magnetic control expert	5	3	ENEA(CREATE), EPFL	2	ENEA(CREATE), EPFL
3.5 Cryo-magnet system simulation and data analysis expert	4	2	ENEA, CEA	2	ENEA, CEA
3.6 Control room monitoring tools/ Synthetic diagnostics expert	6	3	ENEA, ENEA(CNR), EPFL	3	ENEA, ENEA(CNR), EPFL
tot PMs(I)		92.5		56.5	

WPSA - 2027 budget requests and priorities (March 2026 evaluation)

Topic	Required resources (PM, hardware, facilities, …)	Associated CC budget* [k€]	Associated EC budget* [k€]	Mission JA (CC)	Associated CC budget* [k€] incl.mission	Associated EC budget* [k€] incl.mission	WP priority (Low, Medium, High)	PSD priority TBD
Installation & commissioning of Tangential Phase Contrast Imaging (TPCI)	6	25.62	28.2	53.55	79.17	70.28	H	
Installation & commissioning of Fast Ion Losses Detector (FILD)	5	21.35	23.5	44.63	66	58.6	H	
Installation & commissioning of Gamma Rays Spectrometer (GRS)	5	21.35	23.5	44.63	66	58.6	H	
Installation & commissioning of Runaway Electron Monitor (REM)	3	12.8	14.1	26.8	39.6	35.2	H	
Installation & commissioning of Pellet Launching System (PLS)	4	17.1	18.8	35.7	52.8	46.9	H	
Analysis tools for operation (Installation and test)	4	17.1	18.8	35.7	52.8	46.9	M	
Support for subsystem operation (EdgeTS, DivVUV, MGI, EDICAM)	**18**	**77**	**84.6**	**161**	**237.5**	**210.83**	**M**	
Design of selected Edge and SOL diagnostics for W transition	48	205	226	-	205	226	H	
Total	93	397	473	401.63	799	753		

*Conversion: 4.27k€ CC/ PM (@average), 4.70k€ EC/PM; HW/facility CC= 0.5*direct cost; HW/facility EC=0.7*direct cost