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Enhancement and Commissioning of JT-60SA (WPSA) Plans for 2026-27

Carlo Sozzi

With contributions of Gloria Falchetto (Code Management, CEA), Matteo Iafra (Operations, ENEA), Juan Ayllon, Pilar Caño Megias, (Enhancements, CIEMAT), Alessandra di Bastiano (ENEA, PSO), Joao Figueiredo (PMU)

ISTP-CNR (ENEA)



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Background

OP1: first plasma

EC assisted breakdown at low $E_{//}$
Plasma control with SC coils
Disruption characterization

Scope=>

OP2: high Ip operation

Extension of the operation domain (high Ip, H mode, Beta, collisionality, ...)
Disruptions and Runaway control, Error field
Heat transport L mode with dominant Electron heating, Shine through, Fast ion losses, LH transition, ELMs, SOL scaling at high IP, Divertor characterization

OP3: H mode development

ITER relevant H-mode and high beta scenarios
High Beta non-inductive steady-state scenarios
NTM, RWM, ST control, Heat transport L mode with dominant Electron heating, Fast ions and turbulence, Alpha particles in D-3He plasma, ELMs regimes, W screening, Seeding

DIAGNOSTICS ENHANCEMENTS

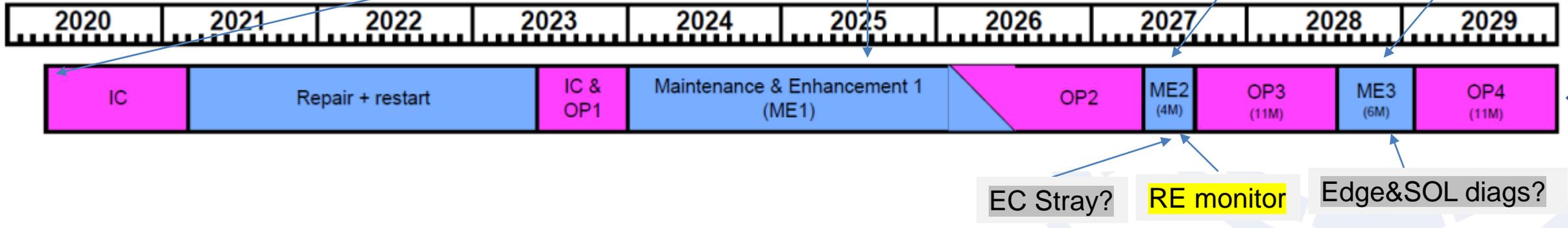
Systems =>

EDICAM

Div. VUV, Edge TS

TPCI, FILD, LaBr3(Ce)
Gamma Sp, CLYC Neut. Sp.

Doppler Refl., VNC?,
LaCl3(Ce) Neut. Sp



Relies on

- consolidation of the present scheme with EuF providing science case, systems foundations, conceptual design and F4E supporting execution engineering and procurement.
- Significant participation to the operations is expected in OP2 (starting from running diagnostics and related data processing and validation)



Presently ongoing development

System under procurement or development	Reference person	Proposed Op.	Present status
FILD	Juan Ayllon (CIEMAT, U. Sevilla)	OP3	Ex-vessel design consolidated and the shielding concept validated by neutronics studies. Ready for procurement
TPCI	Stefano Coda (EPFL)	OP3	Components to be installed in ME-1 delivered. Mechanical design complete
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)	?	<ul style="list-style-type: none">Al₂O₃+TiO₂ as the primary absorbing material for the bolometer systemrobust bolometer design validated through MISTRAL laboratory tests and W7-X operationssniffer probe design moving into the laboratory testing and calibration
Gamma-ray spectrometer	Massimo Nocente (ENEA, UNIMIB)	OP3	Design phase for the JT-60SA LaBr ₃ (Ce) Gamma-ray Spectrometer complete. Ready for procurement.
EU Neutron diagnostics (Vertical Neutron Camera)	Marco Ceconello (VR)+IPPLM team	?	conceptual layout and material composition for the VNC collimator and detector units
EU Neutron spectrometer	Davide Rigamonti (ENEA-CNR)	OP4 tbc	confirmed the feasibility of a LaCl ₃ -based compact spectrometer for 2.5 MeV neutron spectroscopy at JT-60SA
RE monitor	Daniele Marocco (ENEA)	OP3	Detailed feasibility completed, hw partially available, ready for procurement
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%.



Objectives in 2026 /1

- Thomson Scattering System
 - Installation of the in-vessel components and connection of the optical system (fibers and collection optics)
 - Laser line tests and calibration
 - Calibration (spatial, in vessel-relative, Raman, polychromators)
 - Development of the analysis software (synthetic diagnostics)
 - System commissioning and exploitation of the edge TS system
 - Explore Real Time solutions
- Divertor VUV
 - Installation of the system in JT-60SA (pre-assembled) and connection of auxiliaries (vacuum, fiber optics, power supplies etc)
 - Alignment with divertor
 - Development of the analysis software (synthetic diagnostics)
 - Commissioning and evaluation/validation of the first spectra against noise
 - Assistance to the Experiment Team for scientific exploitation in OP2
- Commissioning and first operation with plasma of the MGI system
- Support for the operation of EDICAM and assistance to data interpretation in particular in assisting the development of high current scenarios



Objectives in 2026 /2

- Support to the development of the Pellet Launching System (Sources development and integration with the launcher)
- Partial ex-vessel installation of the TPCI diagnostics
- Laboratory integration of the FILD diagnostics
- Support to neutronics calculation for diagnostics shielding and for the development of the collimator of the Gamma Rays Spectrometer and of the Compact Neutron Spectrometer
- Neutron Spectrum Reconstruction from Radiation Foil Sensors for evaluating the radiation levels and the validation of the MCNP model
- Procurement and lab test of the Gamma Ray Spectrometer
- Design of the Compact Neutron Spectrometer
- Installation, commissioning and support to operation of the Runaway Electron Monitor
- Training for users of the developed Pulse Design Simulator and other tools: EC waves tools, ATEP (Advanced Transport for Energetic Particles) workflow, MHD stability chain (sensitivity of the MHD unstable spectra to variations on the q-profile)
- Support the design of the Doppler Reflectometry
- Support the design of the Vertical Neutron Camera (profile monitor)
- Selection of Edge and SOL diagnostics feasibility studies for advancement to detailed conceptual design



Objectives in 2027

- Thomson Scattering System
 - Exploitation and support to operation in OP2
 - Raman calibration between OP2 and OP3 campaign
 - Support to operation in OP3 (on site + remote)
 - Support to operation of EDICAM (on site + remote)
- Installation and commissioning of FILD
- Installation and commissioning of TPCI
- Installation and commissioning of $\text{LaBr}_3(\text{Ce})$ Gamma Spectrometer
- Installation and commissioning of Runaway Electron Monitor
- Development of the Pellet Launching System (
 - Scientific support to sources development (F4E tender) and integration with the launcher
 - Integration and laboratory test
- Procurement and characterization of the $\text{LaCl}_3(\text{Ce})$ Compact Neutron Spectrometer
- Finalize the design of Doppler Reflectometry
- Finalize the design of the Vertical Neutron Camera
- Support the development of the selected Edge and SOL diagnostics (NOT funded at present)



Grant Milestones and Deliverables

ID	Milestone Title	Date	Comments
	Commissioning of the Edge Thomson Scattering diagnostics in JT-60SA completed	31.12.2026	

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	



Management

- Confirmation of the Area Coordinators for Operations (Matteo Iafrati, ENEA) and Code Management (Gloria Falchetto, CEA)
- Change of the ENHancements Area Coordinator (Pilar Cano Megia, CIEMAT – Univ. Seville)
- MGI commissioning role did not receive any proposals following the 2025 call
- After the call closed, direct contact was made with the experts.
- This was already reported to the PB in October (see slide 10, https://indico.euro-fusion.org/event/3661/contributions/15446/attachments/7281/12987/WPSA26-27_PB_Oct2025_csozzi_v01.pdf)
- MPG offered support, and after consultation in FSD an agreement was reached for their involvement.



Present 2026-2027 plan (resources)

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(NCBI), VR,FZJ,DTU	5	ENEA, IPPLM(NCBI), 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), NCSR	3	ENEA(CNR), NCSR, 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	



Enhancements activities 2026

Activity	Resources Beneficiary	PMs (tot 48.5)
Coordination of WPSA Enhancements Area 2026	CIEMAT	2
Simulation/CAD works for Neutronics assessments 2026	IPPLM	2
Neutron Spectrum Reconstruction and Activation Foils studies 2026	IPPLM	2
Support to neutronics activities 2026	LEI	1
Design and Procurement of a Doppler Reflectometer	CIEMAT	6
Support activities for VNC and CNS development	VR	2
Design and procurement of a Vertical Neutron Camera	IPPLM	2
Development of a Runaway Electron Monitor	ENEA	1
FILD procurement	CIEMAT	6
Tangential Phase Contrast Imaging system procurement, and partial installation 2026 + synthetic diagnostics	EPFL	5.5
Gamma-ray spectrometer design and procurement 2026 - ENEA	ENEA+UKAEA	5
Compact Neutron Spectrometer design and procurement 2026	ENEA	4
Pellet injection system design and procurement 2026	MPG	8
Feasibility of a Directional Electron Probe diagnostics	FZJ	1
Assess the accuracy of a CTS system measurement using the existing in-vessel structures of the ECRH system.	DTU	1



Code Management activities 2026

Activity	Beneficiary	PMs (tot 15.5)
Coordination of SA.CM in 2026	CEA	2
Magnetic control tool demonstrated on a relevant scenario_ENEA	ENEA+EPFL	3.5
PDS optimised and applied to JT-60SA hybrid scenario	CEA + ENEA	4
Data analysis tools adapted to OP-2	ENEA	2
EC HCD and ECE modelling tools	ENEA + NCSR	2
Tools in support of OP 2 magnets operation	CEA+CEA	2

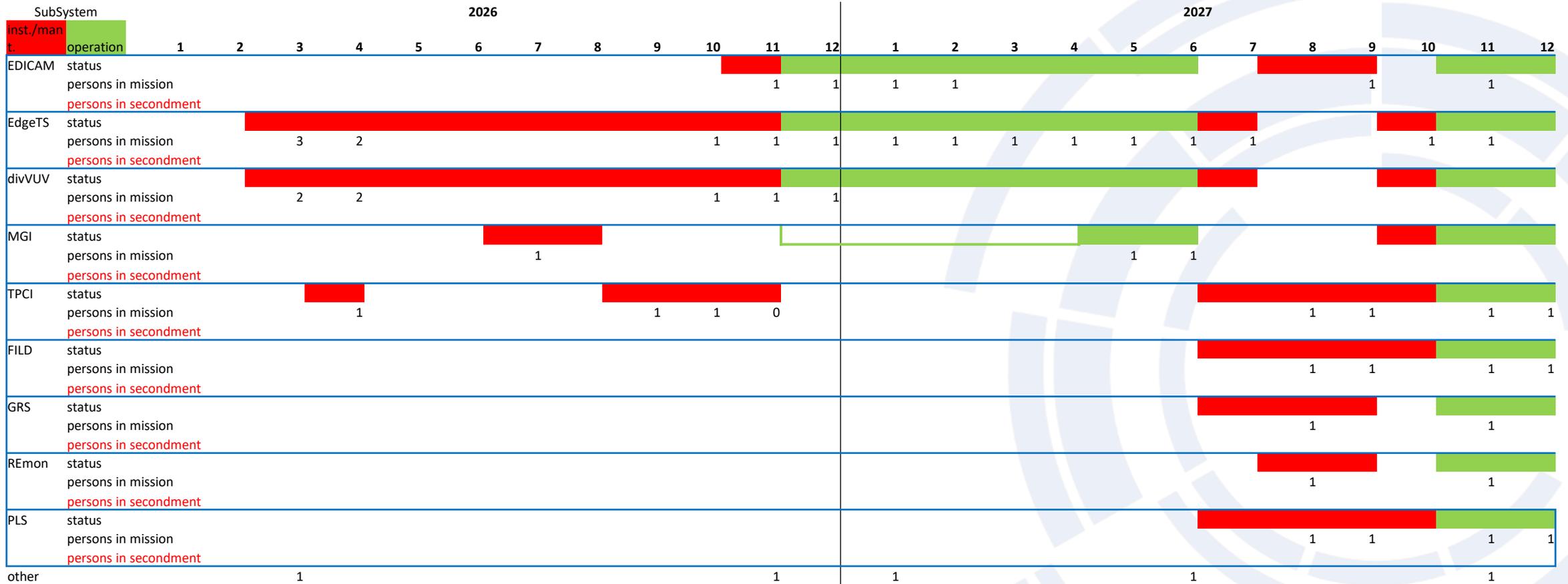


Operations activities 2026

Activity	Beneficiary	PMs (tot 24.5)
Coordination of the Operations Area	ENEA	2
Thomson Scattering TRO	ENEA+IAP	9
Divertor VUV spectroscopy TRO	ENEA+IAP	7
EDICAM expert	EK-CER	3
Operational tools and preparation of operations in view of OP2	CEA	1.5
MGI expert	MPG	2



Planned presence on site (presently allocated budget)



- Timeline coherent with the present scientific and operational planning of JT-60SA
- Resources allocated to WPSA are insufficient to complete the commissioning of the EU-led systems (about +6ppy would be needed)
- Secondment scheme (again F4E supported) for long term stays expected for a small number of diagnosticians (~2,3 or up to 1ppy/system), to be activated as soon as the conditions allow



Boundary conditions

- Planning for the period 2026-2027 is based on the assumption that a significant part of the engineering design, engineering analysis and procurement assistance can be supported through F4E- Beneficiary Institution contracts.

F4E contracts	scope	starting period
TPCI	engineering and installation	late 2026
TS	Installation and operation	mid 2026
VUV	maintenance or operation	mid 2026
DR	engineering	late 2026
FILD	engineering and installation	late 2026

- For such cases, the WPSA support will go only to the scientific PL of the enhancement project, or for the preliminary design needed to reach the maturity to sign a PA (F4E-QST)
- 9 good new diagnostics proposals for the preparation, still to be discussed/accepted by the Experiment Team (detailed reports [available](#))
- Essentially no budget in 2026-27 for their further development (~+48 PMs)



WPSA - 2027 budget requests and priorities

Topic	Required resources (PM, hardware, facilities, ...)	Associated CC budget* [k€]	Associated EC budget* [k€]	Mission JA (CC)	Associate d CC budget* [k€] incl.mission	Associate d 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		



Back-up slides





Desired presence on site (~+45 PMs in 2027)

