

FSD Planning Meeting June 2024 – AWP 2025

## Exploitation of JT-60SA (WPSA)

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Supporting material on indico (see links in WPSA wiki)

ISTP-CNR (ENEA)



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## 2024 – Revision of the program: WPSA changing scope

- Scientific exploitation moved under WPTE
- JIFS organization moved under TRED (WPSA part of the Advisory Board/Working Group)

In view of the significant upgrade that JT-60SA will face in the next years, WPSA shall focus on:

- development of operation-oriented tools, synthetic diagnostics, analysis tools and connected training sessions/events
- preparation of the design phases of the enhancements and related activities, including the relevant modeling useful to set specifications, requirements and performance limits,
- scientific assistance to F4E for the procurements
- preparation and assistance for the testing, installation, integration and commissioning of the components/instrumentation
- operation of the systems until the release of validated data (commissioning with plasma) => operation in scientific campaign tbd
- Contributing to the preparation of remote participation and exploration/development to allow (partial) remote maintenance of systems
- participation/contribution to systems and machine commissioning before and during plasma operations
- reviewing of the subsystems in preparation of the transition to W wall and proposal of the necessary upgrades and modifications, in connection with the other involved EuF WPs other



## 2024 ongoing activities extending in 2025

- Pre-assembly, acceptance test and delivery on site [2024 or early 2025] of the components of the remaining EU led systems under implementation for the installation in the Machine Enhancement 1 of JT-60SA ([Thomson Scattering](#), [Divertor VUV](#)).
- ([PLS procurement being reorganized](#) as a consequence of the extruder not being delivered. Not ready in 2025).
- Advance the preparation for EU-led system for integration and commissioning. [2024] Assess needs in terms of installation and commissioning procedures, calibration (eg, [VUV](#)), impact on the machine time, specifying the target plasmas for calibration/commissioning [2025].
- [FILD](#) completing design [2024]=>procurement and delivery in 2025 (installation later)
- Launch design [2024] and start of procurement [2025] of third set of Enhancements
  - [Tangential Phase Contrast Imaging](#) [final design in 2024, procurement in 2025]
  - [GAMMA diagnostics](#) [identification of the driver scenario and detector position in 2024, detailed design in 2025]
  - [Doppler Reflectometry](#) [identification of port and space to start the detailed baseline design, 2024], Design validation in 2025
  - [Neutron profile monitor and Neutron spectroscopy](#). Conceptual design can be started as soon as input on location, LOS, MNCP calculation available [2024], detailed design in 2025.
- Test of ITER prototypes of [EC stray sensors](#). Release of specification of coatings and acquisition [2024]=> new team and extension of scope to fast detector response [2025]
- Advance [remote data access/participation](#) including IMAS interface under development, test of remote control of a passive diagnostics (EDICAM), [2024]=> further test under different protocol/architecture (thrusted site) [2025]
- Release/ $\beta$ -testing of machine-oriented simulation tools and workflows, cross-training (EU-JA), benchmarking of [magnetic control tools](#) , [Operational tools and conditioning](#) [2024] => training to users [2025]



# 2024 starting activities developing in 2025

- New activities being launched
  - Proposals for EDGE diagnostics
  - Feasibility for multiple EDICAM
  - Feasibility for a CTS diagnostics
  - Explore test of ITER Hall sensor prototypes
  - New phase of W preparation & related enhancements: diagnostics, protection, additional power...
  - Assessment of the acceptable PLS performance for the first scientific phase.=> re-adaptation of parts from JET/PELIN/AUG... and related task
  - Organization of Operations and (exchange of) training on operational tools
- Overall boundary conditions under definition:
  - Activity of insulation reinforcement/repair needed to reach the nominal performance (incl. CS)
  - Strategy and time plan for W transition



# WPSA Code Management Area: 2024

Area Coordinator : G Falchetto (CEA)

1. Progress towards the release of validated simulation tools for JT-60SA scientific exploitation
2. Support to the JT-60SA Topical Groups leaders for IC analysis and modelling activities

Operation oriented tools	codes	Activity – 2024 deliverable	Modelling of Initial Research Phase and nominal scenarios *
<a href="#">Discharge simulator</a>	NICE-METIS + CREATE-NL controllers (implementing JT-60SA specifics) + EGENE <a href="#">Artaud Mattei</a>	Long term effort since 2020. <a href="#">Artaud Mattei</a> 2024 : publication/demonstration of closed loop on a JT-60SA full scenario – optimization of ramp up/down; <a href="#">pulse simulator β-testing</a>	<a href="#">Scenario development and analysis – ORD + T&amp;C</a> Good synergy with EU; new scenario from MESC improved & provided by METIS
<a href="#">Breakdown simulator</a>	BKDO+GRAY for kinetics & EC power absorption + CREATE-BD for magnetics <a href="#">D Ricci M Mattei</a>	Synergetic activity with TE (validation) & PrIO (development & IMASization) 2024: application to JT-60SA Trapped Particle Configuration (TPC) breakdown method	
<a href="#">Error field workflow</a>	<a href="#">L Pigatto (RFX Padova)</a>	Develop workflows for model-based Error Field correction (in view of OP-2) Using a proxy EF correction current references for each scenario can be obtained	<a href="#">MHD and control Runaway modelling MHD</a>
<a href="#">Energetic particle workflow</a>	ATEP (in IMAS/validated on AUG) <a href="#">Lauber (IPP) + ASCOT (VTT)</a>	Synergetic to TSVV & ENR ATEP 2024: upgraded EP-WF/ATEP codes to deal with JT-60SA specific PNBI- and NNBI-generated distribution functions ; benchmarked EP transport models (kick and quasi-linear limit) for at least one JT-60SA scenario	<a href="#">Edge and divertor modeling PED + SOL</a>
<a href="#">MHD stability workflow</a>	MHD stability chain (in IMAS by ITM/CD <a href="#">R Coelho</a> )	Provide a training on the MHD stability workflow on the OP-2 OP-3 target scenarios, as identified by the ET	<a href="#">Energetic Particles modelling EP</a>
Cryo & magnets modelling	TACTICS THEA STREAM SIMCRYOGENICS <a href="#">Le Coz Nicollet Bonne (CEA)</a>	Long term involvement of CEA team in supporting JT-60SA magnets & cryo Activity driven monitored & synergetic with F4E (L Zani) for IC. 2024 <ul style="list-style-type: none"> <li>• <a href="#">TF and EF Thermohydraulic models &amp; application for predictions</a></li> <li>• EF STREAM model prediction <a href="#">for heat loads deposition</a></li> <li>• <a href="#">SIMCRYOGENIC development for JT-60SA operation</a></li> </ul> + <a href="#">Magnetic characterization of conductor samples &amp; QDV analysis (SA.OP)</a>	<b>EXP TEAM → WPTE</b> Last minute new task following F4E WPDIV request:
Synthetic diagnostics			<a href="#">Assessment of SOL and divertor plasma conditions with W wall in high performance scenarios – for PFC design</a>
<a href="#">FILD synthetic diagnostics</a>	FILDSIM <a href="#">Manolo G-M+ EEG univ Sevilla</a>	Synergetic to PrIO FILD synthetic diagnostics development 2024 same task as in PrIO coming from ITER CDR output: collimator optimization for specific JT-60SA settings	





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<a href="#">Breakdown simulator</a>	BKDO+GRAY for kinetics & EC power absorption + CREATE-BD for magnetics D Ricci M Mattei	Synergetic activity with TE (validation) & PrIO (development & IMASization) 2024: application to JT-60SA Trapped Particle Configuration (TPC) breakdown method	If development completed => Apply for analysis OP1, OP2 (ET), transfer to TSVV15 (PDT)
<a href="#">Error field workflow</a>	L Pigatto (RFX Padova)	Develop workflows for model-based Error Field correction (in view of OP-2) Using a proxy EF correction current references for each scenario can be obtained	Apply to OP1 (ET/WPTE) and OP-2 preparation
<a href="#">Energetic particle workflow</a>	ATEP (in IMAS/validated on AUG) Lauber (IPP) + ASCOT (VTT)	Synergetic to TSVV & ENR ATEP 2024: upgraded EP-WF/ATEP codes to deal with JT-60SA specific PNBI- and NNBI-generated distribution functions ; benchmarked EP transport models (kick and quasi-linear limit) for at least one JT-60SA scenario	=> ET/WPTE?
<a href="#">MHD stability workflow</a>	MHD stability chain (in IMAS by ITM/CD R Coelho)	Provide a training on the MHD stability workflow on the OP-2 OP-3 target scenarios, as identified by the ET	=> ET/WPTE?
Cryo & magnets modelling	TACTICS THEA STREAM SIMCRYOGENICS Le Coz Nicollet Bonne (CEA)	Long term involvement of CEA team in supporting JT-60SA magnets & cryo Activity driven monitored & synergetic with F4E (L Zani) for IC. 2024 <ul style="list-style-type: none"> <li>• <a href="#">TF and EF Thermohydraulic models &amp; application for predictions</a></li> <li>• EF STREAM model prediction <a href="#">for heat loads deposition</a></li> <li>• <a href="#">SIMCRYOGENIC development for JT-60SA operation</a></li> </ul> + <a href="#">Magnetic characterization of conductor samples &amp; QDV analysis (SA.OP)</a>	New task: test of 2 <sup>nd</sup> gen CCG to be installed in ME1 (starting 2024, main work in 2025)
<b>Synthetic diagnostics</b>			<b>=&gt;include TS, VUV</b>
<a href="#">FILD synthetic diagnostics</a>	FILDSIM Manolo G-M+ EEG univ Sevilla	Synergetic to PrIO FILD synthetic diagnostics development 2024 same task as in PrIO coming from ITER CDR output: collimator optimization for specific JT-60SA settings	Full diagnostics simulation



# Preparation of transition of JT-60SA to W wall and divertor

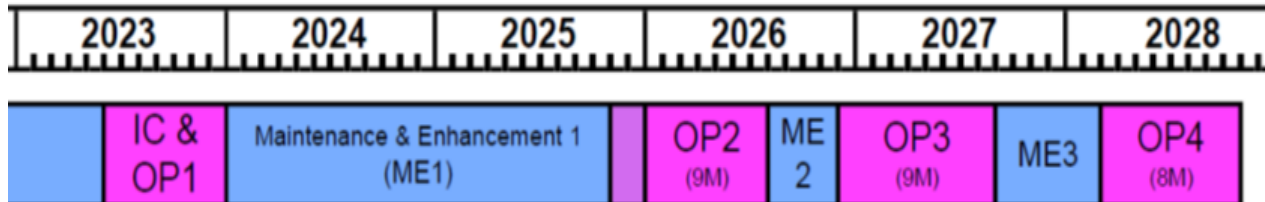
- Objectives: Clarification of the scope and main driver(s) for the W environment in JT-60SA.
  - Fastest possible implementation, accepting limitations in the reachable performance
  - Best possible scenario performance taking the necessary time to develop and test the key technologies and components
  - Test technologies and components in preparation of DEMO and in support ITER operation
  - ...



# Preparation of transition of JT-60SA to W wall and divertor

Research phase	Focus of exploitation	Operation Campaign	Expected operation schedule	1	Annual neutron limit	RH	Divertor	Installed NB power	ECRF	Max. usable aux. power <sup>2</sup>
Initial research phase I	Integrated Commissioning	Op-1	2020-2021 (6M) 2023 (6M) First plasma 2023	H	-	R&D	Open upper inertially cooled carbon <sup>3</sup>	0	1.5 MW (2 Gyro.)	1.5MW
	<b>Initial stable and reliable operation</b> <ul style="list-style-type: none"> <li>H operation for commissioning towards D operation.</li> <li>Stable operation at high current heated plasma</li> </ul>	Op-2	2026~	D			3.2e19	Lower pumped carbon with intershot cooling <sup>4</sup> (limits high power heating duration)	PNB 8 units, plus NNB Total 16MW (with H) 23.5 MW (with D)	3 MW (4 gyro)
Initial research phase II	<b>ITER and DEMO regime access</b> (high power and high Ip with short pulses) <ul style="list-style-type: none"> <li>Access to ITER-relevant high confinement H-mode at high Ip</li> <li>High beta access</li> <li>ITER risk mitigation (ELM, disruption)</li> </ul>	Op-3	TBD		D	3.2e19				
		Op-4	TBD	33 MW						
		No. of campaigns to be confirmed	TBD	33 MW						
Integrated research phase I	<b>High beta and metal wall compatibility</b>	TBD	TBD		4.0e20	Use	Actively cooled lower pumped tungsten	Total 30 MW	7MW (9 gyro.)	37MW
Integrated research phase II	<b>High beta long pulse Burning plasma relevant</b> <ul style="list-style-type: none"> <li>ITER standard and hybrid stationary (~2-3τ<sub>R</sub>)</li> <li>High beta steady-state (~2-3τ<sub>R</sub>), DEMO contribution</li> </ul>	TBD	TBD	1.0e21	34MW <sup>5</sup>					41MW
Extended research phase		TBD	TBD	1.5e21						

- **Sequence and the time schedule of the actions to be performed** (Assuming the installation of the W PFCs after OP4)
- Proposal for the organization of the work [2024]
- Identification of the key contact persons in each one of the contributing WPs or other EuF areas [2024]
- Identify the existing tasks contributing to the workplan [2024]
- Identify possible gaps and how to fill them [for the 2025 programme]







# Preparation of transition of JT-60SA to W wall and divertor

## Key contributors and roles

- **WPTE, liaising with the JT-60SA Experiment Team**
  - identification and proposal of the scientific objectives for the transition
  - propose and coordinate preparatory modelling, analysis, experiments on the operating machines
  - develop requirements for the enhancements program
- **WPDIV**
  - development of the PFC components coherently with the identified scope and requirements
- **WPPWIE**
  - Input on Plasma-Wall interaction and optimal PFC shaping
  - Test of components
- **WPSA, liaising with F4E**
  - Development of the enhancements projects coherent with the identified requirements
  - assist the implementing agencies in procurement, testing and commissioning of the enhancements
  - Collection of the previous experiences (AUG, WEST,...)
- **W7-X**
  - test of W PFCs (EU and JA samples)
  - Auxiliaries development (diagnostics, protection, heating)
- **Other?**

