RT12 priorities in 2027

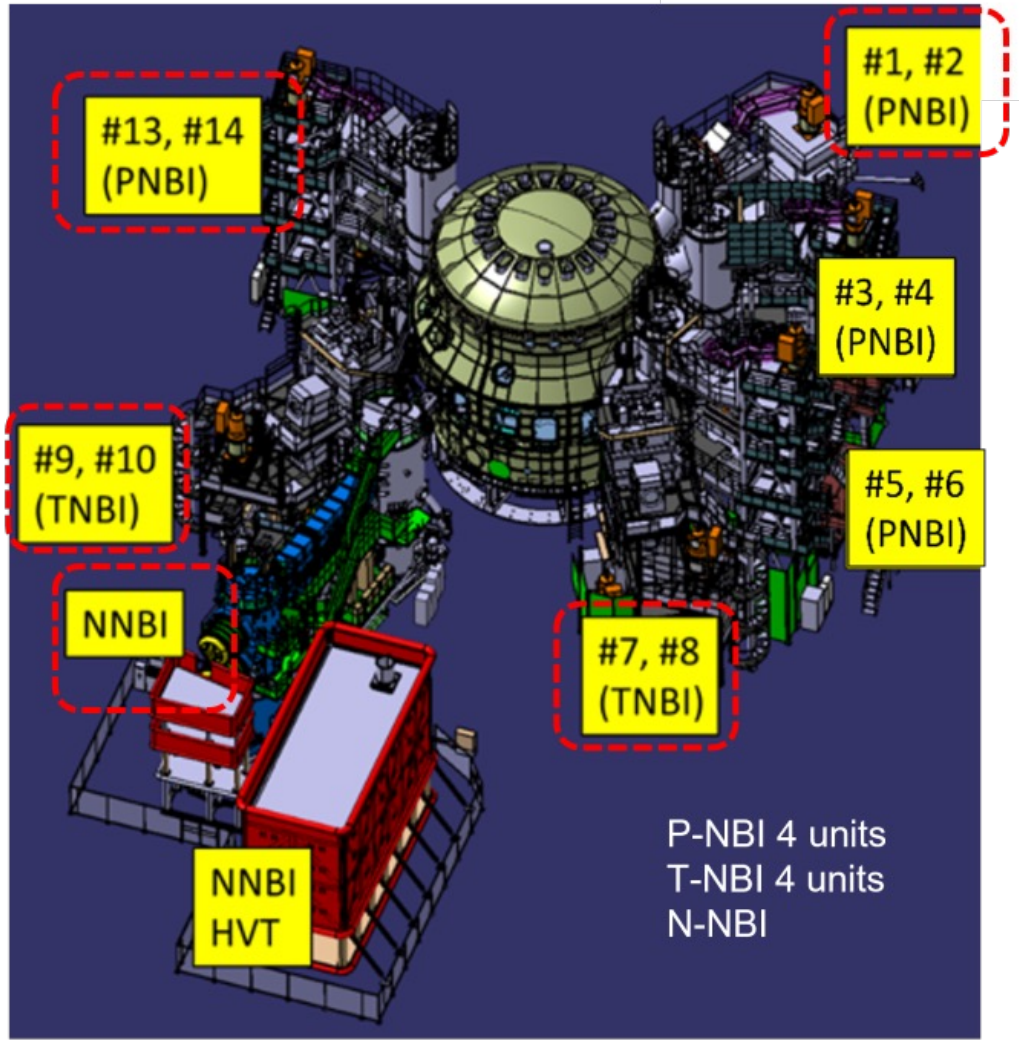
JT-60SA TG ‘Operation Scenario Development’

JT-60SA TG Leader: T. Wakatsuki (QST)
WPTE Coordinator: L. Garzotti (UKAEA)

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WPTE General Planning Meeting, 10 November 2026



Selected TG-ORD experiments for OP2

OP2 experiment	EC	Co-EC
M01: H-mode baseline scenario development	T. Wakatsuki (QST)	O. Sauter (EPFL)
M04: Plasma current extension in L-mode	S. Kojima (QST)	L. Bonalumi (CNR-Milan)
M09: Plasma density control	H. Sakai (QST)	G. Derks (DIFFER)
M10: Plasma shape control	S. Inoue (QST)	F. Fiorenza (CREATE)
M11: ECRH/ECCD control and impact on sawteeth*	E. Alessi (CNR-Milan)	H. Yamazaki (QST)
M13: Breakdown and plasma initiation optimisation	N. Tsujii (Tokyo Univ.)	M. Mattei (CREATE)
M22: Initial advanced scenario development	S. Inoue (QST)	M. Marin (EPFL)
M23: Initial hybrid scenario development	G. Pucella (ENEA)	T. Wakatsuki (QST)

**** jointly with TG-MHD***

OP2 cycle #1: Hydrogen plasma, I_p < 3MA

	Tuesday	Wednesday	Thursday	Friday
Week #1: no NBI [09/03 – 12/03]	M12: ECWC (1/2)	M09: Density control	M10: Plasma shape control	**Contingency (2/3)**
	M04: Increasing I_p ~ 2-3MA	M12: ECWC (2/2)	**Contingency (1/3)**	**Contingency (3/3)**
Week #2: IC activities [16/03 – 19/03]	**Integrated Commissioning (4 days):** pulse extension for N-NBI (Hydrogen) 350keV → 450keV → 500keV, Δt ~ 3-5s			
Week #3 [23/03 – 26/03]	**Weekly inspection** [national holiday – 22/03]	M14-M18: T&C/PEP block (1/2) [also: heat flux validation]	**Contingency (1/3)**	M02: Shinethrough (1/2)
Week #4 [30/03 – 02/04]	**Contingency (2/3)**	M02: Shinethrough (2/2)	M14-M18: T&C/PEP block (2/2) [also: heat flux validation]	**Contingency (3/3)**

- **Major highlights:** shinethrough exps. [M02]; validation of heat flux calculation for future high-power exps. [M19], [M20]
- Extra candidates for contingency (w/o NBI): ECRH/ECCD [M11]; start-up optimisation [M13], error-field studies [M03]
- Extra candidates for contingency (with N-NBI): sawtooth modification by ECRH/ECCD [M11]

More details: Y. Kazakov, ETM-11

OP2 cycle #2: H → D changeover, I_p < 3MA

	Tuesday	Wednesday	Thursday	Friday	
Week #1: no NBI [06/04 – 09/04]	M03: Error-field studies (1/3)	M03: Error-field studies (2/3)	**Contingency (1/2)**	**Contingency (2/2)**	H_2 fuelling
	M12: ECWC optimization	M11: ECRH/ECCD control	M03: Error-field studies (3/3)	M05: Initial disruption studies with MGI	
	Integrated Commissioning: change gas for P-NBI (H → D)				
Week #2: IC activities [13/04 – 16/04]	**Integrated Commissioning (4 days):** pulse extenstion for P-NBI (Deuterium), Δt ~ 5s *If the P-NBI extension can be completed in 3 days, the additional day will be allocated to Experiment Team studies*				
Week #3 [20/04 – 23/04]	M03: NBI and EFCC [high-power exps.]	M14-M18: T&C/PEP block (1/2) [high-power exps.]	M07: Neutron validation & NBI confinement (1/2) [high-power exps.; +shinethrough]	**Contingency (1/2)** [high-power exps.]	
Week #4 [27/04 – 30/04]	M14-M18: T&C/PEP block (2/2) [high-power exps.; + test ECRF/gas modulation]	M07: Neutron validation & NBI confinement (2/2) [high-power exps.; +shinethrough]	**National holiday [29/04]**	**Contingency (2/2)** [high-power exps.]	

- **Major highlights:** Error-field studies [M03]; monitor H/(H+D) [M12]; core estimate H/(H+D) [M07]; shinethrough in H-mode [M02]
- Extra candidates for contingency (w/o NBI): ECRF/ECCD demonstr., incl. power modulation [M11]; test of W-TESPEL [M18]
- Extra candidates for contingency (with N-NBI): fast ions and AEs [M08]

More details: Y. Kazakov, ETM-11

Cycle #3: Deuterium plasma, I_p < 3MA

	Tuesday	Wednesday	Thursday	Friday
Week #1: no NBI [11/05 – 14/05]	**Preparation for H-mode** M10: Plasma shape (0.5 s.) M09: Density control (0.5 s.) M11: ECRH/ECCD control (0.5 s.) M04: Max. plasma current (0.5 s.)	**Contingency (1/3)** M06: RE generation and control (1/2)	**Contingency (2/3)** [+ M18: test of W-TESPEL] M05: Disruptions at low plasma current	**Contingency (3/3)** M06: RE generation and control (2/2)
Week #2 [18/05 – 21/05]	M01: H-mode devel. (1/2)	M01: H-mode devel. (2/2)	**Contingency (1/5)** [M01: H-mode dev., 0.5 s.]	**Contingency (2/5)** [evening: intentional L-mode disruption at ~3MA, M05]
Week #3 [25/05 – 28/05]	M14-M18: T&C/PEP block (1/3) [high-power exps.]	M14-M18: T&C/PEP block (2/3) [+ M18: W-TESPEL test]	M02: Shinethrough [+ M07: neutron validation]	**Contingency (3/5)** [evening: intentional L-mode disruption at >3MA, M05]
Week #4 [01/06 – 04/06]	M14-M18: T&C/PEP block (3/3) [high-power exps.]	M08: Fast ions and AEs [H-mode and L-mode]	**Contingency (4/5)**	**Contingency (5/5)**

IC: Machine inspection after the first disruption at I_p ~ 3MA

- **Major highlights:** H-mode development at I_p < 3MA [M01]; ITER-relevant shinethrough [M02]; W-TESPEL in H-mode [M18]
- Extra candidates for contingency (w/o NBI): ECRF and gas modulation test, [M11] and [M09]
- Extra candidates for contingency (with N-NBI): sawtooth modification by ECRF/ECCD [M11]

More details: Y. Kazakov, ETM-11

Cycle #4: Deuterium plasma, high-current I_p > 3MA

Option #1 (preferred):
change of N-NBI to deuterium (Y_n ~ 5x10^{16} s^{-1})

Week #1: no NBI [08/06 – 11/06]	* 20kA CS test (4 days) * N-NBI: change gas from H to D
Week #2: IC act. [15/06 – 18/06]	* Pulse extenstion for N-NBI (D), Δt ~ 5s * High-power gyrotron test (> 1MW/unit inj.)
Week #3 [22/06 – 25/06]	* M01: H-mode at I_p ~ 4MA [+ W-TESPEL test] * M02 & M08: Shinethrough and fast ions (L-mode) * M04: High-current L-mode, I_p ~ 5MA (evenings)
Week #4 [29/06 – 02/07]	* DSOL studies: M19-M21 (2 days) * EL contingency (M22 & M23 – tbc) (2 days)

Weekly neutron budget constraint:

H-mode & L-mode pulses mixed during the day;
H-mode scenario development distributed throughout the week

Option #2 (backup plan):
keep N-NBI in H until the end of the campaign (Y_n ~ 1x10^{16} s^{-1})

Week #1: no NBI [08/06 – 11/06]	* 20kA CS test (4 days) * No change of N-NBI gas
Week #2 [15/06 – 18/06]	* M01: H-mode at I_p ~ 4MA [+ W-TESPEL test] * M04: High-current L-mode, I_p ~ 5MA (evenings) [Bonus: dedicated H-mode T&C studies; start DSOL activities]
Week #3 [22/06 – 25/06]	DSOL studies: 4 days * M19: Heat flux decay length characterisation * M20: Impact of divertor geometry on SOL * M21: Impurity seeding (Ne/Ar)
Week #4 [29/06 – 02/07]	EL contingency: 4 days [Candidates: high-beta plasmas, M22 & M23; high-power gyrotron test > 1MW/unit inj., M11]

Note: all OP2 experiments, B_t ~ 2.25T (except [M22] and [M23])

More details: Y. Kazakov, ETM-11

RT12 – M01 ‘H-mode baseline scenario development’

M01: H-mode baseline scenario development

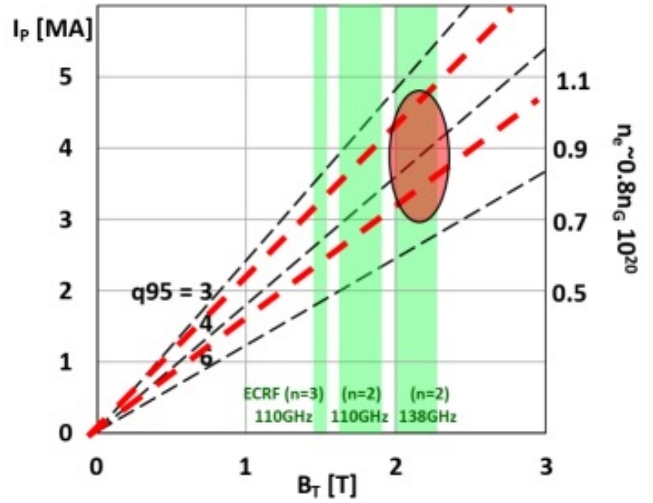
Experiment Coordinator: T. Wakatsuki (QST, Japan)
Co-EC: O. Sauter (EPFL, EU)

Deliverables	
M01-D1	Develop a stable and reproducible H-mode baseline scenario for subsequent physics studies
M01-D2	Assess plasma controllability in the baseline scenario
M01-D3	Benchmark baseline performance against established scaling laws and other C-wall tokamaks
M01-D4	Provide data to identify and characterize a critical MHD mode in the baseline scenario
M01-D5	Integrate W-TESPEL injection into the baseline scenario to enable dedicated W transport analysis
Extended goals	
M01-E1	Test higher-confinement baseline H-mode scenario (H_{98} > 1.0)

Session distribution in OP2

Cycle #1	Cycle #2	Cycle #3	Cycle #4
0	0	2-2.5	N-NBI (D): ~1.5-2 N-NBI (H): ~2-3

Deuterium plasma:
I_p > 3MA experiments at the end of OP2



RT12 – M01 ‘H-mode baseline scenario development’

Deliverables	
M01-D1	Develop a stable and reproducible H-mode baseline scenario for subsequent physics studies
M01-D2	Assess plasma controllability in the baseline scenario
M01-D3	Benchmark baseline performance against established scaling laws and other C-wall tokamaks
M01-D4	Provide data to identify and characterize a critical MHD mode in the baseline scenario
M01-D5	Integrate W-TESPEL injection into the baseline scenario to enable dedicated W transport analysis
Extended goals	
M01-E1	Test higher-confinement baseline H-mode scenario (H_{98} > 1.0)

Session distribution in OP2

Cycle #1	Cycle #2	Cycle #3	Cycle #4
0	0	2-2.5	N-NBI (D): ~1.5-2 N-NBI (H): ~2-3

- Cycle #3: the first priority is to establish a stable H-mode baseline scenario at I_p ~ 2.5-3MA (H_{98} ~ 1).
  If the available CS flux and auxiliary heating power permit, operation at higher I_p should also be explored
- Cycle #3: H-mode scenario will be developed using hydrogen N-NBI in a deuterium plasma
  (to avoid weekly neutron budget constraints and allow more flexible scenario development)
- Cycle #4: further develop baseline scenario at higher plasma current (ref. for M19-M21 exps.)
  The choice on N-NBI species (deuterium or hydrogen) will be made at the end of Cycle #3
- D3 provides data for M16 analysis; D5 provides data for M18 analysis

RT12 – M04 ‘Plasma current extension in L-mode’

M04: Plasma current extension in L-mode
Experiment Coordinator: S. Kojima (QST, Japan)
Co-EC: L. Bonalumi (CNR-Milan, EU)

Deliverables	
M04-D1	Develop stable L-mode plasmas at I_p ~ 2-3 MA in H, H-D and D plasmas
M04-D2	Develop high-current L-mode plasmas at I_p > 3MA in D plasmas
M04-D3	Assess plasma shape optimization for high I_P studies
M04-D4	Optimise the ramp-down phase and test RTC systems for safe landing
Extended goals	
M04-E1	Advance RTC preparations for future use in OP3

Session distribution in OP2

Cycle #1	Cycle #2	Cycle #3	Cycle #4
1	0	1	N-NBI (D): dedicated pulses N-NBI (H): dedicated pulses

This experiment is scheduled in support of the main scenario development. The extended goal shall be reconsidered referring to the status of required control logic implementation in QST.

RT12 – M09 ‘Plasma density control’

M09: Plasma density control

Experiment Coordinator: H. Sakai (QST, Japan)
Co-EC: G. Derks (DIFFER, EU)

Deliverables	
M09-D1	Develop robust density control scheme in L-mode
M09-D2	Test density feedback for H-mode studies
M09-D3	Test gas modulation demonstration in L-mode plasmas
Extended goals	
M09-E1	Test gas modulation demonstration in H-mode plasmas

Session distribution in OP2

Cycle #1	Cycle #2	Cycle #3	Cycle #4
1	0	0.5	0

This experiment will contribute to the stable I_p-ramp for the scenario development and physics experiments which require density control. [M09] is scheduled in the early phases of H and D plasma operation in case the characteristics are different between H and D; D3 and E1: in support of [M14] and [M16].

RT12 – M10 ‘Plasma shape control’

M10: Plasma shape control
Experiment Coordinator: S. Inoue (QST, Japan)
Co-EC: F. Fiorenza (CREATE, EU)

Deliverables	
M10-D1	Test controllability of highly-shaped plasmas in L-mode for the following H-mode scenario development
M10-D2	Test divertor-strike point control for heat flux control
M10-D3	Create database for plasma control scheme development in OP2
M10-D4	Improve equilibrium control schemes for their future use in OP3
Extended goals	
M10-E1	Initial development of AI/ML methods for the VDE avoidance

Session distribution in OP2

Cycle #1	Cycle #2	Cycle #3	Cycle #4
1	0	0.5 (+dedicated pulses)	Dedicated pulses

[M10] will mainly focus on the flat-top phase, to be complementary to the I_p-extension experiment [D3 of M04]. The purpose of this study is to contribute to the follow-up development of high-performance plasmas.

RT12 – M11 ‘ECRH/ECCD control and impact on sawteeth’

M11: ECRH/ECCD control and impact on sawteeth
Experiment Coordinator: E. Alessi (CNR-Milan, EU)
Co-EC: H. Yamazaki (QST, Japan)

Deliverables	
M11-D1	Characterise electron temperature and current profile controllability with ECRH/ECCD
M11-D2	Test the impact of ECRH/ECCD on sawteeth
M11-D3	Validate ECRH control-room modelling tools
M11-D4	Conduct a test of ECRH power modulation
Extended goals	
M11-E1	Purity of EC polarization modes
M11-E2	Long-period sawtooth modification by ECRH/ECCD (studies with N-NBI)
M11-E3	Test high-power gyrotron operation for future applications in JT-60SA

Session distribution in OP2

Cycle #1	Cycle #2	Cycle #3	Cycle #4
0-0.5 (contingency)	1	0.5	0

Note: [M11] is a joint experiment shared by the JT-60SA Topical Groups ‘Operation Regime Development’ and ‘MHD’. To simplify the selection process, participants interested in contributing to **[M11]** should provide their **IMS responses only to RT12** (TG-ORD).

Example:
RT12 – M11 – M11-D1: [proposed workplan]
RT12 – M11 – M11-E2: [proposed workplan]

More details on M11 scientific objectives:
G. Pucella, RT-13 priorities, this afternoon

D4: in support of [M14] and [M16]; E2: Long-period sawtooth modification by ECRH/ECCD (studies with N-NBI), if contingency allows (extra note: synergies with [M07] & [M08])

RT12 – M13 ‘Breakdown and plasma initiation optimisation’

M13: Breakdown and plasma initiation optimisation

Experiment Coordinator: N. Tsujii (Tokyo University, Japan)
Co-EC: M. Mattei (CREATE, EU)

Deliverables	
M13-D1	Develop a stable plasma breakdown scenario
M13-D2	Assess the operating space for plasma initiation
M13-D3	Conduct low voltage EC-assisted plasma initiation
Extended goals	
M13-E1	Optimise the EC-assisted plasma initiation
M13-E2	Compare experimental results with start-up modelling

Session distribution in OP2

Cycle #1	Cycle #2	Cycle #3	Cycle #4
0-1 (only if needed)	0	0	N-NBI (D): 0 N-NBI (H): 0.5-1 (for B_t = 1.7T)

- Cycle #1: the dedicated session will be considered if the start-up scenario developed during the Integrated Commissioning is not sufficiently stable for experiments
- Cycle #4: start-up at 1.7T will be required for the M22 and M23 high-beta experiments

RT12 – M22 ‘Initial advanced scenario development’

M22: Initial advanced scenario development

Experiment Coordinator: S. Inoue (QST, Japan)
Co-EC: M. Marin (EPFL, EU)

Deliverables	
M22-D1	Test high-beta advanced scenario at JT-60SA
M22-D2	Investigate the *q*-profile tailoring capability
M22-D3	Characterise ITB formation and confinement
M22-D4	Compare experimental observations with predictive modelling
Extended goals	
M22-E1	Characterise low-*Z* and mid-*Z* impurity behavior in reversed-shear plasma
M22-E2	Inject W-TESPEL in the advanced scenario plasmas
M22-E3	Assess the 3rd harmonic ECRH capability for central heating

Session distribution in OP2

Cycle #1	Cycle #2	Cycle #3	Cycle #4
0	0	0	N-NBI (D): tbd N-NBI (H): ~1.5

The goal of [M22] is the initial development of higher beta plasma aiming at $\beta_N \sim 3$ (transient) in reversed-shear plasmas; E2: provide data for [M18] analysis.

RT12 – M23 ‘Initial hybrid scenario development’

M23: Initial hybrid scenario development
Experiment Coordinator: G. Pucella (ENEA, EU)
Co-EC: T. Wakatsuki (QST, Japan)

Deliverables	
M23-D1	Test hybrid scenario at JT-60SA
M23-D2	Critical MHD mode identification
M23-D3	Characterise confinement of the hybrid scenario
M23-D4	Comparison with first-principle predictive modelling
Extended goals	
M23-E1	Characterise low-*Z* and mid-*Z* impurity behavior in the hybrid scenario plasma
M23-E2	Inject W-TESPEL in the hybrid scenario plasmas
M23-E3	JET / JT-60SA similarity studies

Session distribution in OP2

Cycle #1	Cycle #2	Cycle #3	Cycle #4
0	0	0	N-NBI (D): tbd N-NBI (H): ~1.5

The goal of this experiment is the initial development of hybrid plasma in JT-60SA; D3: in cooperation with TG-T&C; an overall view of the confinement characteristics is important for defining next target in OP3 and OP4;
E2: provide data for [M18] analysis.

RT12 – WSA ‘Support for future JT-60SA operations and W-PFC transition’

WSA : Support for future JT-60SA operations and W-PFC transition

Deliverables	
WSA-D1	Integrated core-edge modelling of high-performance scenarios for the C-PFC phase, leveraging the validation of OP2 results and refinement of modelling tools to improve predictive capabilities for future operations
WSA-D2	Integrated core-edge modelling of W-PFC-relevant scenarios (both at nominal and reduced field), using state-of-the-art integrated modelling tools
WSA-D3	Develop requirements for W analysis and provide support for diagnostic enhancements for future W-PFC operations
WSA-D4	Develop requirements for plasma control for future operations in full-W environment

RT12 – Summary

OP2 experiment	EC	Co-EC
M01: H-mode baseline scenario development	T. Wakatsuki (QST)	O. Sauter (EPFL)
M04: Plasma current extension in L-mode	S. Kojima (QST)	L. Bonalumi (CNR-Milan)
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M23: Initial hybrid scenario development	G. Pucella (ENEA)	T. Wakatsuki (QST)

**** jointly with TG-MHD***

- **More details on RT-12 modeling activities (2026):** L. Garzotti et al., WPTE Review Meeting, 06 Nov. 2026
- Modelling activities: support the preparation of OP2 experiments
- New contributors for JT-60SA: before defining / starting any modelling activities for OP3+ scenarios, please discuss your plans with JT-60SA EU EL and TGLs

RT12 – Summary

- **More details on RT-12 modeling activities (2026):** L. Garzotti et al., WPTE Review Meeting, 06 Nov. 2026
  - Boundary reconstruction codes, including algorithms towards RTC
  - Modelling in support of breakdown and ramp-up optimisation
  - Modelling of baseline, hybrid and advanced scenarios in support of OP2 experiment preparation
  - Code benchmarking (power deposition NBI/ECRH, neutron rate, …)
  - Negative triangularity
  - …

European long-term mission experts in support of JT-60SA Experiment Team activities	
1. Gianluca PUCELLA (ENEA)	MHD Physics Coordinator Expert (JT-60SA Topical Group Leader 'MHD'; also co-EC of M05 and EC of M23)
2. Leonardo PIGATTO (RFX)	Non-axisymettric Coil Expert (also EC of M03)
3. Dirk STIEGLITZ (IPP-Garching)	IMAS and Integrated Data Analysis Expert
4. Edmondo GIOVANNOZZI (ENEA)	Data Visualisation Expert
5. Adriano STAGNI (RFX)	Data Visualisation Expert (also co-EC of M21)
6. Rachele CICIONI (RFX)	Integrated Modelling Expert
7. Attila BUZAS (HUN-REN)	Diagnostic Expert (EDICAM)
8. Andrea BELPANE (RFX)	Diagnsotic Expert (VUV Spectrometer)
9. Federico D'ISA (RFX)	Diagnostic Expert (Edge Thomson Scattering)

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WPSA