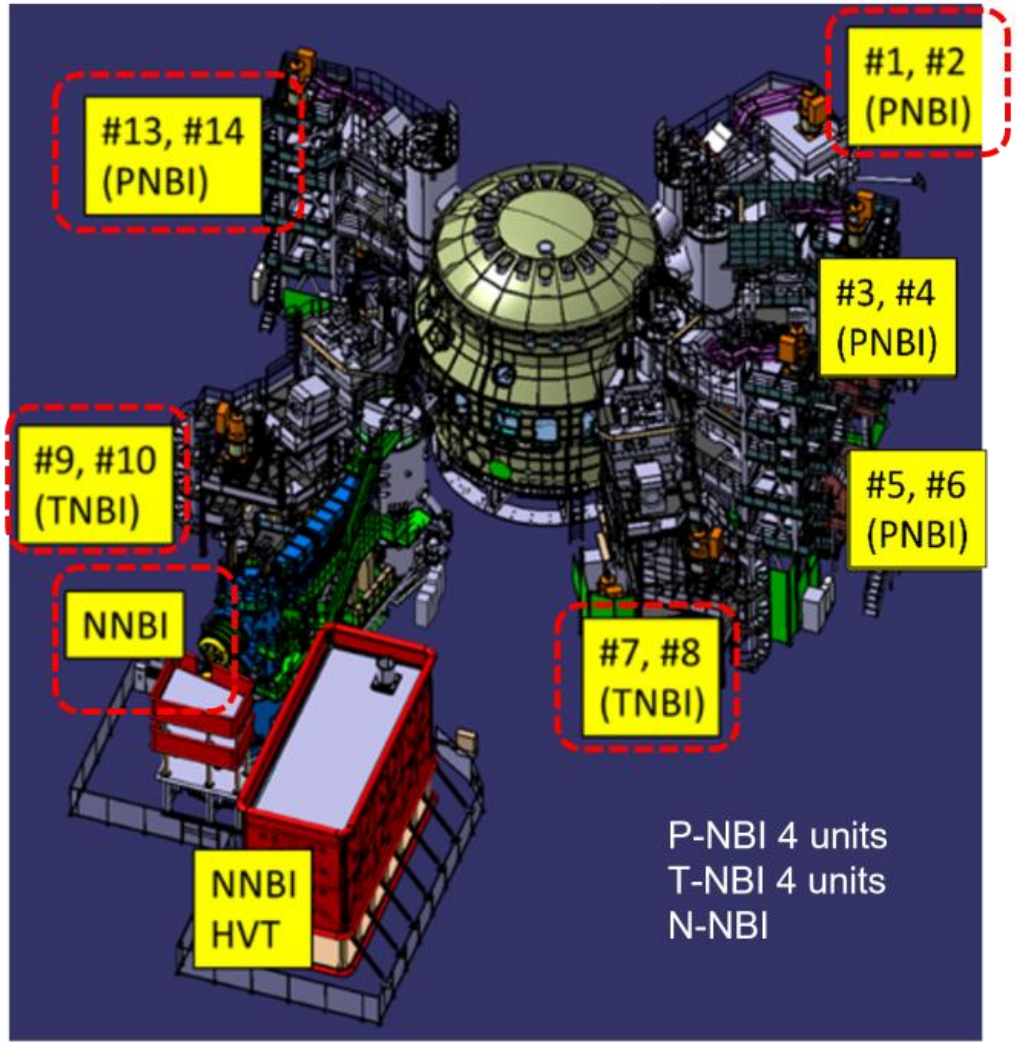
JT-60SA: Machine Status and OP2 Priorities

Yevgen Kazakov

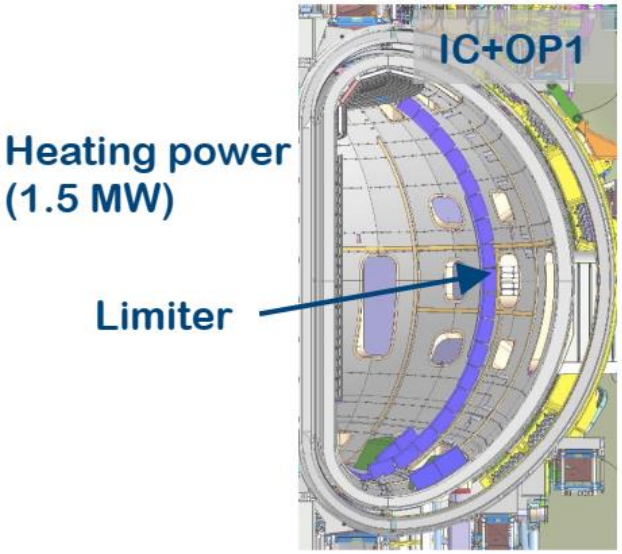
JT-60SA EU Experiment Leader
WPTE Deputy Task Force Leader

** Laboratory for Plasma Physics, LPP-ERM/KMS, Brussels, Belgium*

WPTE General Planning Meeting
Monday, 9 November 2026



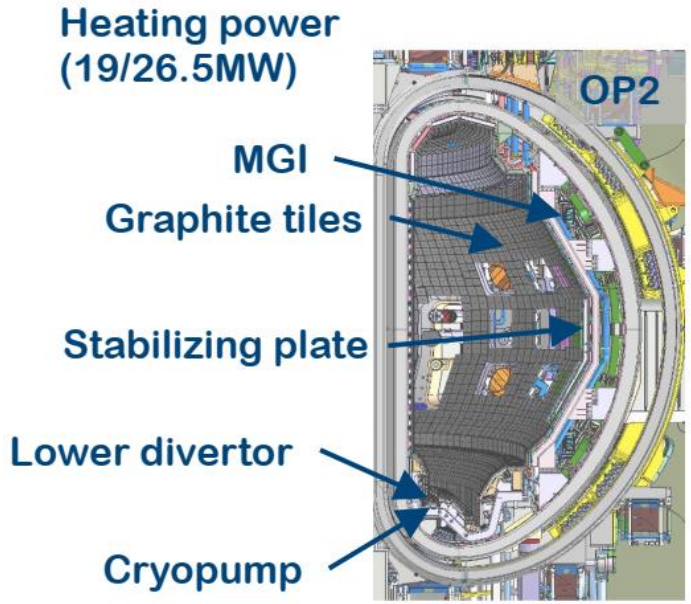
JT-60SA Enhancements for OP2



J. Garcia et al., *Nucl. Fusion (2026)*
M. Yoshida et al., *Plasma Phys. Control. Fusion* (2025)

ME1 phase

- ECRF: 1.5MW → 3MW
- NBI: 0MW → 16MW (H) / 23.5MW (D)
- Inertially cooled divertor with a cryopump
- Several plasma control coils (EFCC, FPPCC, RWMCC)
- MGI for disruption mitigation
- Stabilizing plate
- Upgraded diagnostics (TS, ECE, CXRS, …)

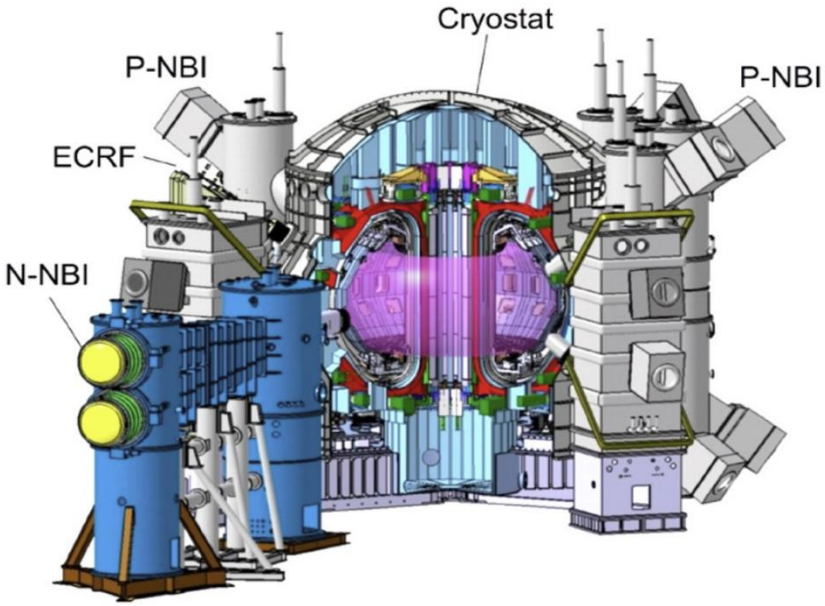


Integrated Commissioning without plasma started in March 2026:

https://www.jt60sa.org/wp/op2-has-started/
https://www.qst.go.jp/site/news/20260313.html

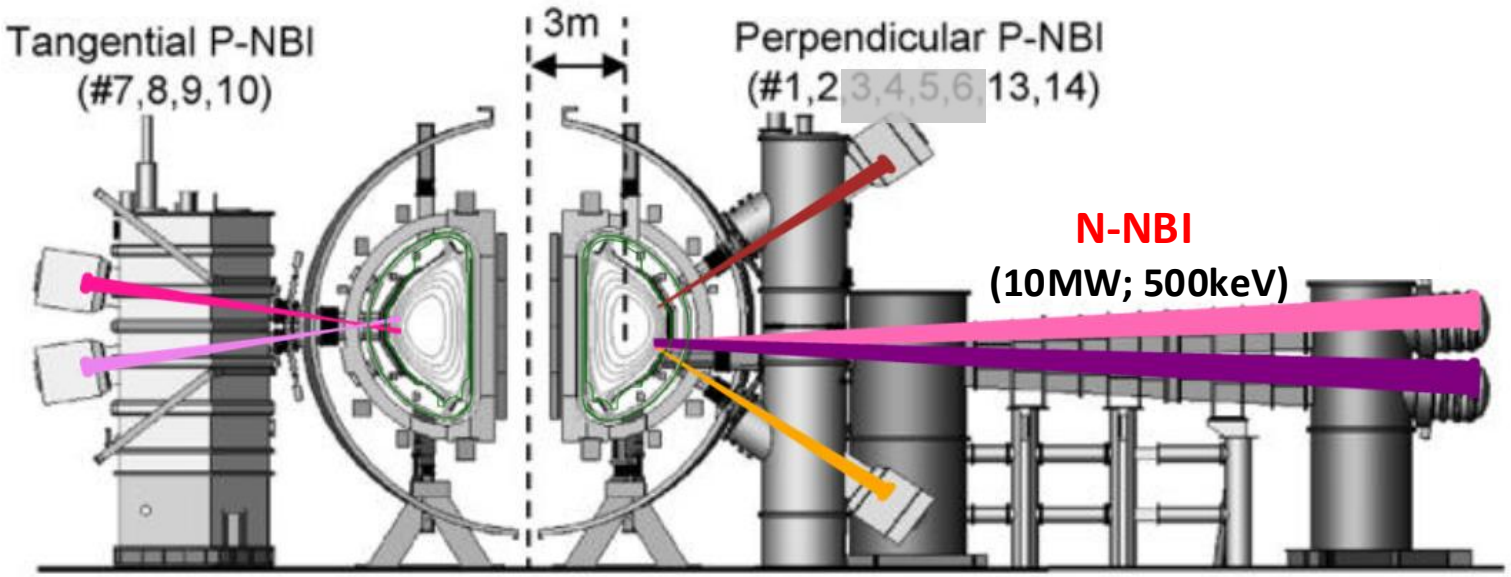
JT-60SA Enhancements for OP2

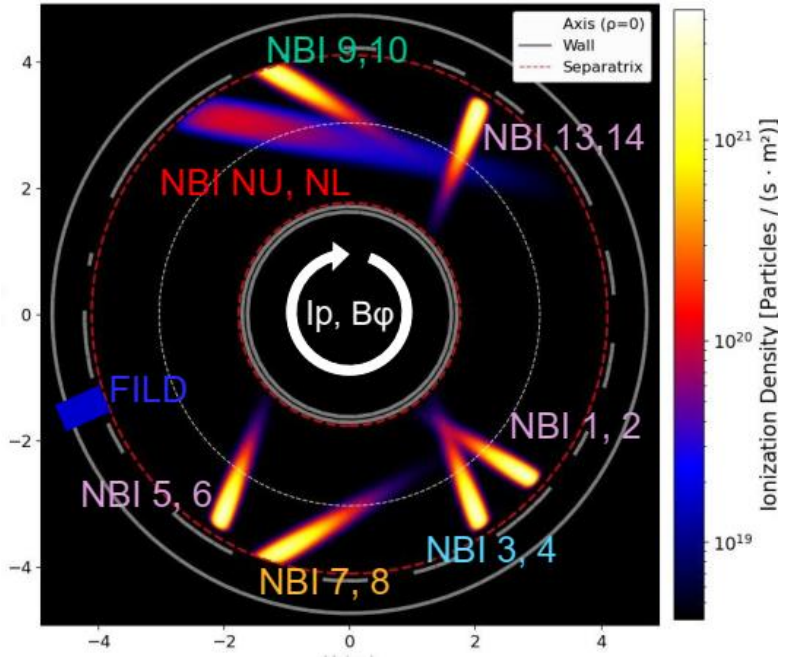
Op-2	Expected operation schedule:		**2026 - 2027**		
	Research phase:	**Initial phase I**	Annual neutron limit:	**-**	**H / D**
Divertor:	Pumped lower inertially cooled carbon divertor Allowable heat flux onto the divertor plate <10MW/m^2 x ~5s, 15MW/m^2 x ~3s (Open upper inertially cooled carbon divertor remains available)				
Installed NBI power:	P-NB Perp	P-NB Tang	N-NB	Total installed NBI	Max usable aux. power: 19 MW in H / 26.5 MW in D
	4 units 3 MW in H / 6.5 MW in D	4 units 3 MW in H / 7 MW in D	2 units 10 MW	16 MW in H / 23.5 MW in D x 14s duty = 1/30	
Installed ECRF power:	1.5MW x 100s (2 gyrotrons 82 / 110 /138 GHz) with steerable launcher + 1.5MW x5s (1 gyrotron: 82 / 110 /138 GHz, 1 gyrotron 110 GHz only) with steerable launcher				



More details: Call for Experiment Proposals for OP2 (30 Oct. 2025)

Plasma heating systems in OP2 (NBI)



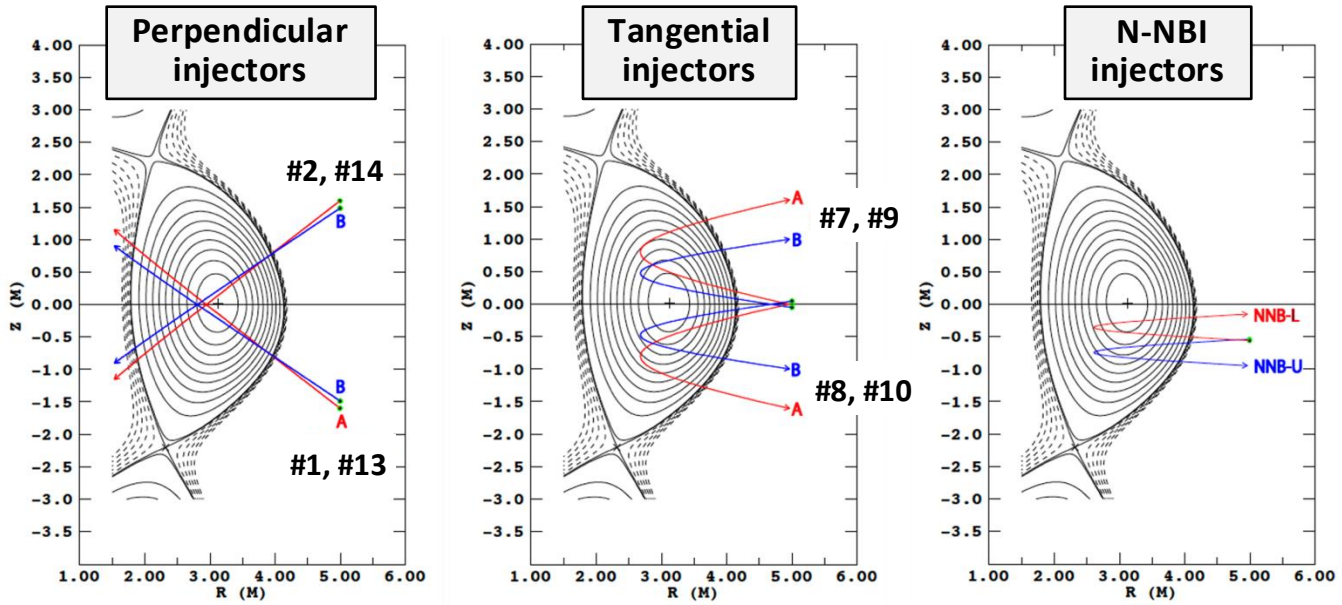


- **NBI in JT-60SA**: can operate with both hydrogen and deuterium beams
- **P-NBI in OP2**: 85keV, 13.5MW (D) vs. 6MW (H)
  [Units #1, #2, #7-#10, #13, #14; per unit: 1.6-1.7MW in D; 0.75MW in H]
- **N-NBI: up to 500keV, 10MW** (flexible: H or D)

Plasma heating systems in OP2 (NBI)

Deuterium: positive NBI (85keV) and negative NBI (500keV)

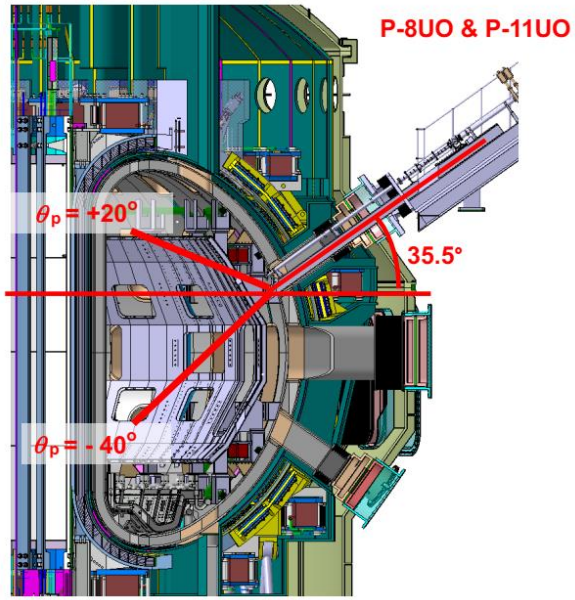
Injector	#1	#2	#13	#14		#7	#8	#9	#10		N-NB(U)	N-NB(L)
	Perpendicular injectors (P-NBI)					Tangential injectors (P-NBI)					Negative NBI	
						(counter-I_p)	(counter-I_p)	(co-I_p)	(co-I_p)			
Power	1.6MW	1.6MW	1.6MW	1.6MW		1.7MW	1.7MW	1.7MW	1.7MW		5MW	5MW
Diagnostics				CXRS, FIDA			MSE		Twin to #8			

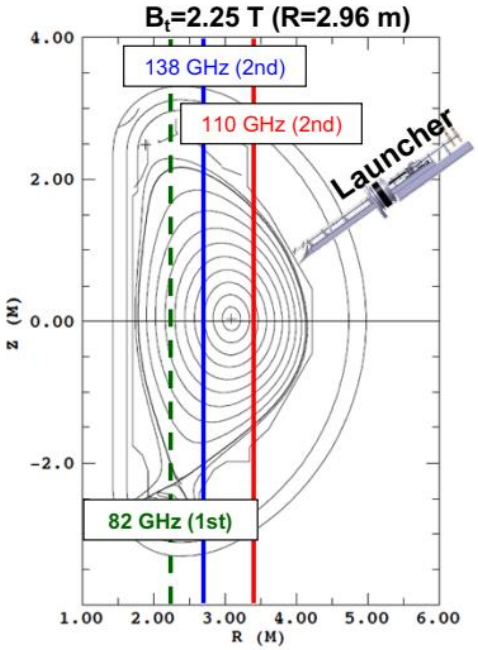


Plasma heating systems in OP2 (ECRF)

ECRH/ECCD

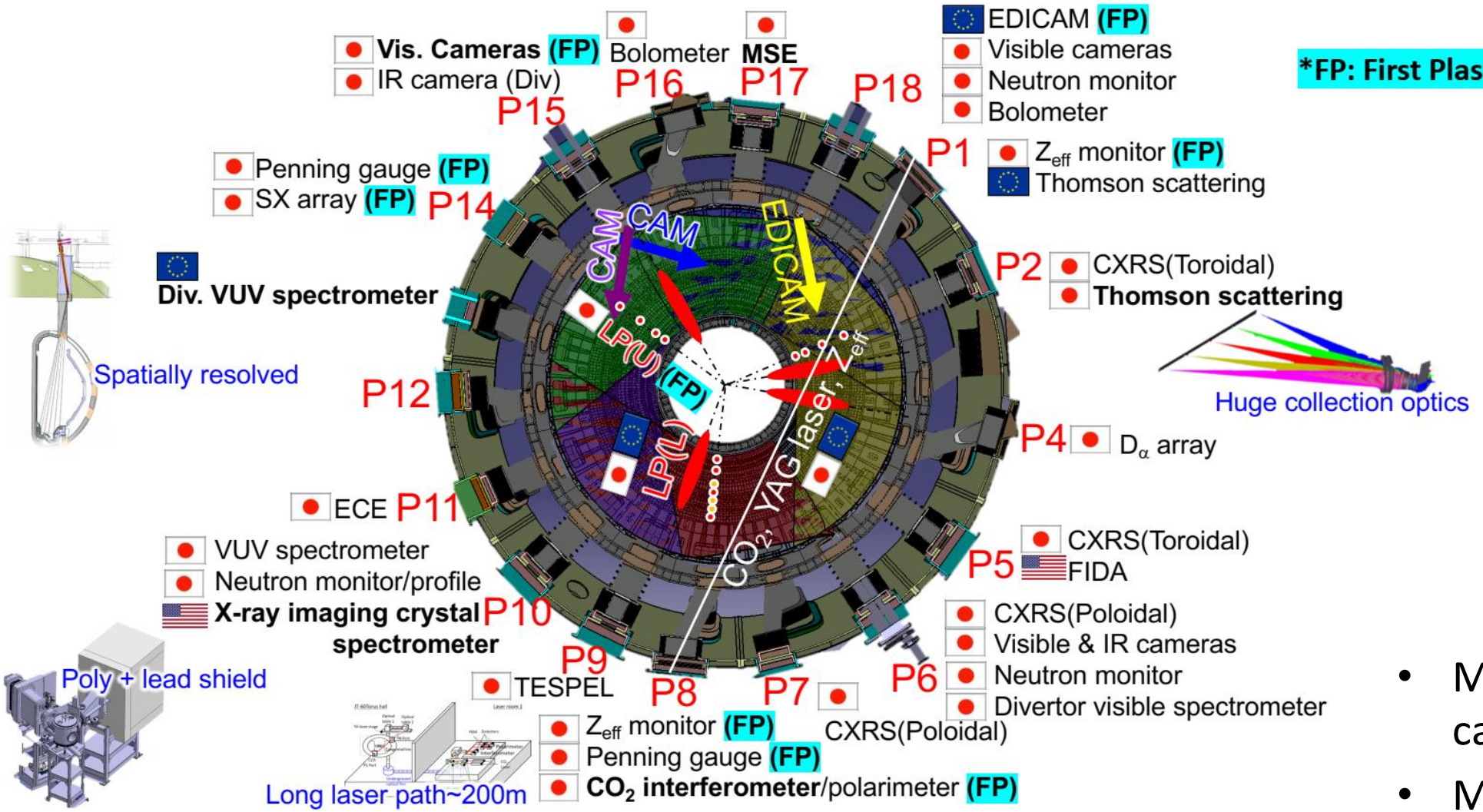
	Unit #1	Unit #2	Unit #3	Unit #4
Frequency	82 / 110 / 138GHz		110GHz	82 / 110 / 138GHz
Duration	100 s (but: 1s for 82GHz)		5s	5s (but: 1s for 82GHz)
Port location	P-11		P-8	





- ECRF: 4 gyrotrons, P_{ECRF} ~ 3MW
- Two ECRF launchers manufactured and installed in P8 and P11 ports
- Steerable launchers
- More details: H. Yamazaki, ETWS-4; M. Fukumoto, ETWS-4

Diagnostics in OP2



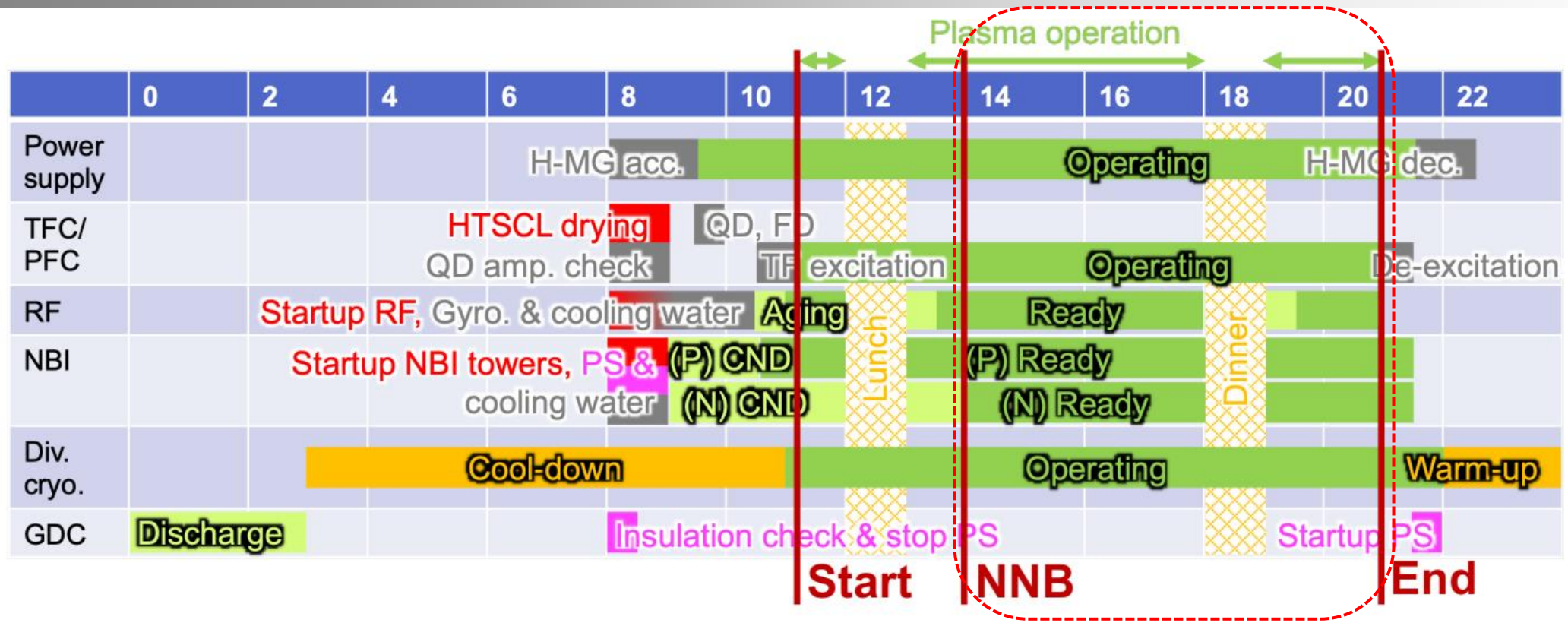
- Most of the essential calibrations completed
- More details [Link]

OP2 operational constraints

- **Operation schedule constraints** (daily; weekly; monthly)
  - Daily operation schedule (see next slide)
  - Mondays: weekly inspection
  - No NBI operation for one week after three weeks of operation
- **Operational constraints in OP2**
  - Several operational constraints, including no water cooling for divertor, NBI targets and ECRH launchers
  - Allowed heat flux onto divertor (repetitive shots ~9s with 10MW/m^2)
  - Shinethrough limits ($\Delta t_{\text{N-NBI}}$ ~ 3-5s requires η_{st} < 15-20%)
  - ECRH mirror heat load
  - Neutron rate budget (weekly limit = 3.1x10^{18} neutrons)
  - **Validation of operational constraints during the Integrated Commissioning and Cycle #1**

More details:
https://qstgojp.sharepoint.com/:u:/r/teams/JT-60SAResearchManagementSite/SitePages/Operation-Constraints-in-Op2.aspx

Typical daily schedule in OP2 (Tuesday – Friday)



- **Summary of OP2 machine constraints:** see ETM presentations by M. Yoshida (ETM-9, ETM-10 & ETM-11)
  - NBI availability: 3 + 1 week sequence (required for the NBI maintenance)
  - Daily operations with N-NBI, ~14:00-21:00 → 1 session per day
  - No-NBI week, ~11:00-21:00 → 2 sessions per day
  - Fridays: plasma operations finishes at 20:30

OP2 milestones and main scientific priorities

No.	Milestone	Planned date	Adjusted date	Comment
1	Completion of port installation	Jul. 2025	-	completed
2	Full-size tungsten HHF elements qualified	Jun. 2026	-	
3	All Op2 RF equipment installed	Jun. 2026	-	
4	In-vessel components installation complete	Jul. 2026	-	
5	NBI withstand voltage testing completed	Jul. 2026	-	
6	VV evacuation for Operation 2	Jul. 2026	Sep. 2026	
7	Calibrated TS profiles (core & edge)	Dec. 2026		
8	Shine-through experiment with NNBI	Feb. 2027		
9	Error field measurement and impact on plasma	Feb. 2027		
10	H-mode plasma achievement	Mar. 2027	-	
11	Demonstration of 20kA PF operation	Mar. 2027	-	
12	Installation of new diagnostics for Operation 3 completed	Sep. 2027		
13	VV evacuation for Operation 3	Dec. 2027	-	
14	Pellet injection into plasma	Mar. 2028	-	
15	High confinement H-mode H_{98}~1, at high current and density	Jul. 2028	-	
16	Impact of high β_N >3.5 on MHD and confinement	Jul. 2028	-	
17	Impact of energetic particles on plasma confinement	Jul. 2028		

Without plasma

With plasma

* OP1: 5kA; start of OP2: 15kA

- Milestones are considered according to the project schedule in the project plan
- Milestones for OP-2 reflect the strategy to
  - **Secure high impact scientific results before higher-risk tests** (e.g. 20kA test*)
  - **Secure high impact scientific results at medium-high plasma current** (before ~20kA PF operation)
  - **Allow enough time before the end of OP2 to try I_p > 3MA experiments** (which require ~20kA PF operation)

Source: J. Garcia, BASC-37, April 2026

* **Note:** dates for certain milestones have been changed; revision ongoing to reflect the latest schedule delays

OP2 milestones and main scientific priorities

No.	Milestone	Planned date	Adjusted date	Comment
1	Completion of port installation	Jul. 2025	-	completed
2	Full-size tungsten HHF elements qualified	Jun. 2026	-	
3	All Op2 RF equipment installed	Jun. 2026	-	
4	In-vessel components installation complete	Jul. 2026	-	
5	NBI withstand voltage testing completed	Jul. 2026	-	
6	VV evacuation for Operation 2	Jul. 2026	Sep. 2026	
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Without plasma

With plasma

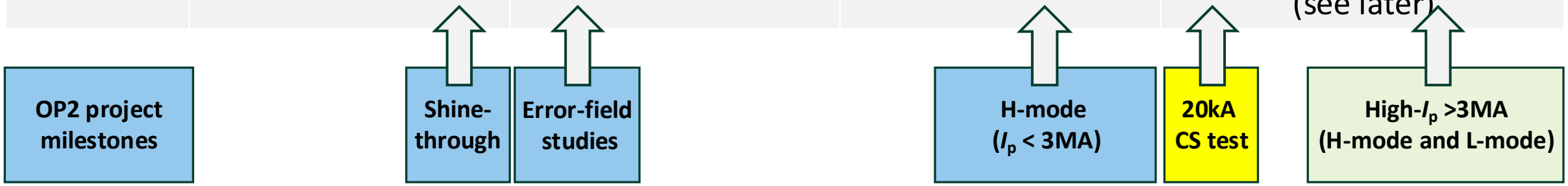
* OP1: 5kA; start of OP2: 15kA

- **Highlight unique features of JT-60SA**
  - High-energy N-NBI and fast-ion physics
  - High-current operation (first, in L-mode)
  - Highly shaped plasmas
- **High-performance scenario development**
  - H-mode operation and characterisation
  - Advancing plasma control systems
  - Towards integrated core-edge scenarios
  - Initial high-beta scenario development
- **Support for W-PFC transition of JT-60SA**
  - Heat flux control experiments
  - W-TESPEL experiments
- **Studies in support of ITER**
  - N-NBI shinethrough experiments
  - Error-field characterisation
  - Disruptions and disruption mitigation
  - Runaway generation and RE mitigation

Timeline for OP2 campaign and cycle planning

- **Integrated commissioning with plasma:** early 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

	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 – available sessions vs. proposals submitted

	No-NBI sessions	NBI sessions	Total
Cycle #1 (H)	8	7	
Cycle #2 (H → D)	8	7	
Cycle #3 (D)	8	12	
Cycle #4 (D)	0	~10 (8-12)	
Total	24	~36	~60

OP2 proposal statistics

Total number of proposals: 160

Number of requested sessions: ~320

OP2 campaign strategy

- Interleave with Integrated Commissioning activities and adapt to evolving machine conditions
- **Maximize synergies during limited OP2 machine time** across proposals, experiments and Topical Groups
- **Maintain ~25-30% contingency** (unforeseen constraints; new machine operation space; new subsystems, …)
- Shift from a proposal-oriented campaign to a **project-oriented campaign** to maximize scientific output

OP2: campaign organization and selection of main experiments

- **Campaign timeline**: structured around the project's milestones and the evolving boundary conditions and specification of several essential systems *(e.g., NBI gas change and pulse extension, H → D changeover)*
- **Highlight the unique features of JT-60SA:** *including high-energy N-NBI, high current and highly-shaped plasmas*
- **Maximize data use and scientific outcome of OP2**: a single experimental session may provide analysis data for multiple selected main experiments
- **Selected main experiments in OP2**
  - Must be planned and prepared with 100% details *(machine requirements, diagnostics, pulse list, …)*
  - Some experiments or deliverables may **not** receive dedicated pulses during OP2 *(piggyback data collection)*
  - Contingency planning: will be distributed by ELs during the campaign
  - **RMS webpage**: central source of information for experiment planning and status, **with up-to-date information maintained by ECs and co-ECs**
- **OP2 publication rules and guidelines – under development;** will be reported at one of the future ETMs
- **Pinboard for publications and conference contributions**

https://qstgojp.sharepoint.com/teams/JT-60SAResearchManagementSite/SitePages/JT-60SA-Pinboard.aspx
https://jt-60saresearchmanagementsite.azurewebsites.net/JT60SAPinboard/

Synergies across Topical Groups in OP2 (example)

T&C/PEP block of experiments [in H, H-D and D plasmas]

Main experiments

- M14: Characterisation of L-mode transport and confinement
- M15: L-H power threshold characterisation
- M16: Characterisation of H-mode transport and confinement
- M17: Pedestal and ELM generation characterisation
- M18: Tungsten transport studies

Comments: define the strategy for 7 sessions to maximize the scientific ouput for the 5 main experiments listed above, keeping consistency across H, H-D and D plasma studies (isotope effect documentation);
dedicated L-H transition pulses after L- and H-mode operational regimes are mapped

Cycle #1	Cycle #2	Cycle #3	Cycle #4
2 (H plasma)	2 (H-D plasma)	3 (D plasma)	Piggyback (D plasma)

'Super'-ECs (to be defined): HMI preparation in the corresponding cycle

Main OP2 experiments selected

https://qstgojp.sharepoint.com/teams/ETCM/SitePages/OP2_main_experiments.aspx

OP2 experiment	EC	Co-EC
M01: H-mode baseline scenario development	T. Wakatsuki (QST)	O. Sauter (EPFL)
M02: Shinethrough studies in support of ITER	S. Sumida (QST)	P. Vincenzi (RFX)
M03: Error-field characterisation and correction	L. Pigatto (RFX)	Y. Ko (QST)
M04: Plasma current extension in L-mode	S. Kojima (QST)	L. Bonalumi (CNR-Milan)
M05: Initial disruption studies and disruption database	T. Yokoyama (QST)	G. Pucella (ENEA)
M06: Initial runaway generation and control studies	U. Sheikh (EPFL)	A. Matsuyama (Kyoto Univ.)
M07: Neutron validation and beam ion confinement studies	R. Coelho (IST)	S. Sumida (QST)
M08: Physics of FI-driven instabilities and their impact on the plasma	S. Mazzi (CEA)	A. Ishizawa (Kyoto Univ.)
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)
M12: Wall conditioning and isotope exchange monitoring	M. Fukumoto (QST)	L. Laguardia (CNR-Milan)
M13: Breakdown and plasma initiation optimisation	N. Tsujii (Tokyo Univ.)	M. Mattei (CREATE)

Main OP2 experiments selected

https://qstgojp.sharepoint.com/teams/ETCM/SitePages/OP2_main_experiments.aspx

OP2 experiment	EC	Co-EC
M14: Characterisation of L-mode transport and confinement	Y. Ohtani (QST)	T. Tala (VTT)
M15: L-H power threshold characterisation	N. Aiba (QST)	L. Aucone (Univ. Milan-Bicocca)
M16: Characterisation of H-mode transport and confinement	C. Angioni (MPG)	Y. Ohtani (QST)
M17: Pedestal and ELM characterisation	L. Frassinetti (KTH)	M. Akimitsu (QST)
M18: Tungsten transport studies in support of JT-60SA W-PFC transition	T. Kawate (QST)	P. Manas (CEA)
M19: Heat flux decay length parametrisation in high-current H-mode	G. Rubino (ISTP-CNR)	R. Matoike (QST)
M20: Impact of divertor geometry on SOL plasma parameters	M. Groth (Aalto University)	R. Sano (QST)
M21: Divertor heat flux control with impurity seeding	T. Nakano (QST)	A. Stagni (RFX)
M22: Initial advanced scenario development	S. Inoue (QST)	M. Marin (EPFL)
M23: Initial hybrid scenario development	G. Pucella (ENEA)	T. Wakatsuki (QST)

- 23 main experiments selected for OP2 (13 ECs from Japan and 10 ECs from EU)

JT-60SA Experiment Team Leadership

Experiment Leaders

*Coordinator



Maiko YOSHIDA*
(QST)



Yevgen KAZAKOV
(LPP-ERM/KMS)



Akihiko ISAYAMA
(QST)

Topical Group Leaders



Operation Regime Development
T. WAKATSUKI
(QST)



MHD Stability and Control
G. PUCELLA
(ENEA)



Transport and Confinement
L. GARZOTTI
(UKAEA)



High-Energy Particle Behaviour
A. BIERWAGE
(QST)



Pedestal and Edge Physics
N. AIBA
(QST)



Divertor, SOL and PMI
T. NAKANO
(QST)

- Experiment Leaders oversee the OP2 campaign
- TGLs supervise related OP2 experiments

TG-ORD

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)



Operation Regime Development

T. WAKATSUKI (QST)

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

WPTE Coordinator: L. Garzotti (UKAEA)

More details: Y. Kazakov 'RT12 – programme priorities in 2027', WPTE Review Meeting, 10 Nov. 2026

TG-MHD

OP2 experiment	EC	Co-EC
M03: Error-field characterisation and correction	L. Pigatto (RFX)	Y. Ko (QST)
M05: Initial disruption studies and creation of the disruption database	T. Yokoyama (QST)	G. Pucella (ENEA)
M06: Initial runaway generation and control studies	U. Sheikh (EPFL)	A. Matsuyama (Kyoto University)
M11: ECRH/ECCD control and impact on sawteeth*	E. Alessi (CNR-Milan)	H. Yamazaki (QST)



MHD Stability and Control

G. PUCELLA (ENEA)

**** jointly with TG-ORD***

WPTE Coordinator: G. Pucella (ENEA)

More details: G. Pucella 'RT13 – programme priorities in 2027', WPTE Review Meeting, 10 Nov. 2026

TG-DSOL

OP2 experiment	EC	Co-EC
M12: Wall conditioning and isotope exchange monitoring	M. Fukumoto (QST)	L. Laguardia (CNR-Milan)
M19: Heat flux decay length parametrisation in high-current H-mode	G. Rubino (ISTP-CNR)	R. Matoike (QST)
M20: Impact of divertor geometry on SOL plasma parameters	M. Groth (Aalto University)	R. Sano (QST)
M21: Divertor heat flux control with impurity seeding	T. Nakano (QST)	A. Stagni (RFX)



Divertor, SOL and PMI

T. NAKANO (QST)

WPTE Coordinator: G. Falchetto (CEA)

More details: Y. Kazakov 'RT17 – programme priorities in 2027', WPTE Review Meeting, 9 Nov. 2026

TG-T&C & TG-PEP

OP2 experiment	EC	Co-EC
M14: Characterisation of L-mode transport and confinement	Y. Ohtani (QST)	T. Tala (VTT)
M15: L-H power threshold characterisation	N. Aiba (QST)	L. Aucone (Univ. Milan-Bicocca)
M16: Characterisation of H-mode transport and confinement	C. Angioni (IPP-Garching)	Y. Ohtani (QST)
M17: Pedestal and ELM characterisation	L. Frassinetti (KTH)	M. Akimitsu (QST)
M18: Tungsten transport studies in support of JT-60SA W-PFC transition	T. Kawate (QST)	P. Manas (CEA)



Transport and Confinement

L. GARZOTTI (UKAEA)



Pedestal and Edge Physics

N. AIBA (QST)

EL comments: *define the strategy for 7 sessions to maximize the scientific ouput for the 5 main experiments listed above, keeping consistency across H, H-D and D plasma studies (isotope effect documentation)*

WPTE Coordinator: L. Garzotti (UKAEA)

More details: L. Garzotti 'RT14 & RT16 – programme priorities in 2027', WPTE Review Meeting, 10 Nov. 2026

TG-HEP

OP2 experiment	EC	Co-EC
M02: Shinethrough studies in support of ITER	S. Sumida (QST)	P. Vincenzi (RFX)
M07: Neutron validation and beam ion confinement studies	R. Coelho (IST)	S. Sumida (QST)
M08: Physics of fast-ion-driven instabilities and their impact on the plasma	S. Mazzi (CEA)	A. Ishizawa (Kyoto University)



High-Energy Particle Behaviour

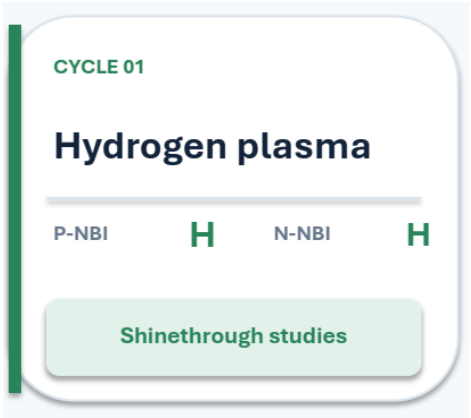
A. BIERWAGE (QST)

WPTE Coordinator: Y. Kazakov (LPP-ERM/KMS)

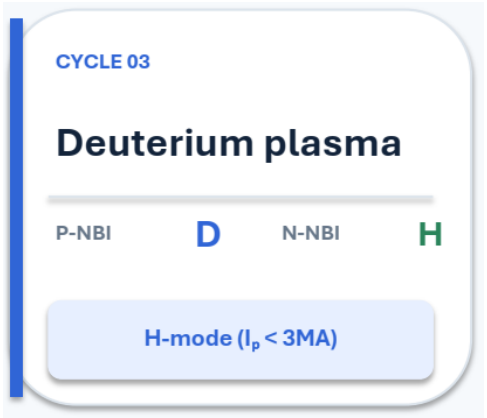
More details: Y. Kazakov 'RT15 – programme priorities in 2027', WPTE Review Meeting, 9 Nov. 2026

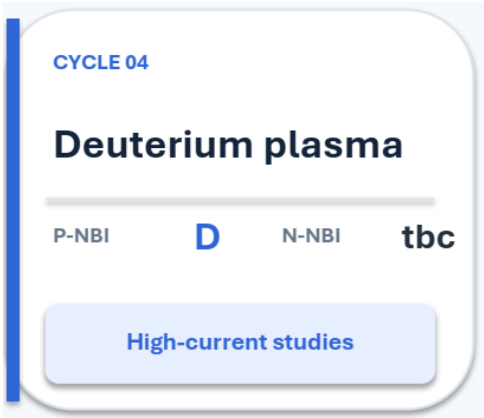
Current status of OP2

- Integrated commissioning w/o and with plasma: early 2027
- OP2 campaign experiments expected to start in March 2027
- The campaign extension to July 2027 under discussion









Call for Participation in OP2 Experiments

WPTE programme for the Campaigns in 2027:
Overview of research topics and categories of required competencies

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WPTE call launched on 02 Nov. 2026

- 04 Dec. 2026: WPTE Call deadline (cf. RT12 – RT18)
  - Part 1: Participation in OP2 experiments (e.g., RT12-M01-D1)
  - Part 2: A&M work in support for future JT-60SA operations (e.g. OP3) and W-PFC transition (e.g., RT12-WSA-D1)
- Week 14-18 Dec. 2026: WPTE Call pre-selection
  [Joint selection by JT-60SA EU EL, WPTE TFLs and JT-60SA TGLs]
- 29 Dec. 2026: JT-60SA Project Call deadline
  [**Note**: The project call does not provide any funding or cover the costs of visits to JT-60SA]
- Jan. 2027: Final approval by JT-60SA ELs and Project
  [EU & JA lists; + ITER and ET members from external institutions to EURATOM and Japan]
- Jan. 2027+: post-deadline applications possible
  [case-by-case consideration by ELs]

WPTE Call for Participation (2027): a few extra comments (1/4)

RT-16 (JT-60SA TG-PEP): Pedestal and Edge Physics

Mission: M1.1
TFL: Y. Kazakov (LPP-ERM/KMS, Belgium)
WPTE Coordinator: L. Garzotti (UKAEA, UK)

JT-60SA Experiment Leaders have defined a block of joint OP2 experiments (M14-M18) to be shared between Topical Groups 'Transport and Confinement' and 'Pedestal and Edge Physics' (see Section on RT-14). A unified strategy for the block of T&C/PEP sessions should be defined to maximize the scientific output of the five main experiments (M14-M18), while ensuring consistency across H, H-D and D plasma studies to support the isotope effect documentation.

To simplify the selection process, participants interested in contributing to M14-M18 should provide their IMS responses only to RT-14 (TG-T&C).

T&C/PEP block of experiments in OP2

- M14: Characterisation of L-mode transport and confinement
- M15: L-H power threshold characterisation
- M16: Characterisation of H-mode transport and confinement
- M17: Pedestal and ELM generation characterisation
- M18: Tungsten transport studies

Participants interested in contributing to M14-M18, please provide your responses in IMS only to RT-14 (TG-T&C)

Example:

RT14 – M14 – M14-D1: [proposed workplan]

RT14 – M18 – M18-E2: [proposed workplan]

WPTE Call for Participation (2027): a few extra comments (2/4)

RT-12 (JT-60SA TG-ORD): Operation Regime Development

Mission: M1.1
TFL: Y. Kazakov (LPP-ERM/KMS, Belgium)
WPTE Coordinator: L. Garzotti (UKAEA, UK)

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

RT-13 (JT-60SA TG-MHD): MHD Stability and Control

Mission: M1.1
TFL: Y. Kazakov (LPP-ERM/KMS, Belgium)
WPTE Coordinator: G. Pucella (ENEA, Italy)

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

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).*

Participants interested in contributing to M11, please provide your responses in IMS only to RT-12 (TG-ORD)

Example:

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

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

WPTE Call for Participation (2027): a few extra comments (3/4)

RT-13 (JT-60SA TG-MHD): MHD Stability and Control

Mission: M1.1
TFL: Y. Kazakov (LPP-ERM/KMS, Belgium)
WPTE Coordinator: G. Pucella (ENEA, Italy)

Scientific objectives

M03: Error-field characterisation and correction
Experiment Coordinator: L. Pigatto (RFX, EU)
Co-EC: Y. Ko (QST, Japan)

Deliverables	
M03-D1	Characterise error-field and locked mode detection with conventional compass scan
M03-D2	Characterise error-field and locked mode detection with non-disruptive compass scan
M03-D3	Test and demonstrate error-field correction with EFCC (ohmic / ECRF-only plasmas)
M03-D4	Provide data to identify and characterize a critical MHD mode in the baseline scenario
M03-D5	Compare the measured error-field penetration thresholds with existing numerical models and ITPA scalings
Extended goals	
M03-E1	Initial assessment of β_N and rotation effects on the error field penetration
M03-E2	Validation of frequency-dependent plasma response model using active MHD spectroscopy

There was a copy-and-paste typo for M03-D4. This is D4 for the main experiment M01 'H-mode baseline scenario development'.

Please ignore M03-D4

Example:

RT13 – M03 – M03-D3: [proposed workplan]

RT13 – M03 – M03-D5: [proposed workplan]

WPTE Call for Participation (2027): a few extra comments (4/4)

Selected European ECs and co-ECs shall apply to the WPTE Call for Participation (2027).

In addition to participating in their selected main experiment, they may also propose contributions to other experiments in OP2.

Example:

RT15 – M02 – Selected co-EC of M02

RT15 – M07 – M07-D2: Benchmark measured neutron rate with ASCOT NBI modelling, in particular in EFCC/NBI experiments

Final note: Proponents interested in participating in JT-60SA related activities (RT12 – RT18) shall belong to the JT-60SA Experiment Team or apply for the ET membership before 04 Dec. 2026

- WPTE wiki in support of JT-60SA activities: https://wiki.euro-fusion.org/wiki/WPTE_JT60SA
- Includes an up-to-date list of JT-60SA Experiment Team members from EUROfusion (currently, 275 members + 1 pending)
- Includes instructions how to apply for the JT-60SA Experiment Team membership
  (open call; fill in Annex 2 with the proposed workplan and send it to the JT-60SA EU Experiment Leader)

Backup slides

More details: ETM-11 meeting, 19 October 2026

https://qstgojp.sharepoint.com/teams/ETCM/SitePages/JT-60SA-Experiment-Team-Meeting.aspx

Cycle #1: Hydrogen plasma, I_p < 3MA

Target: N-NBI conditioning (E_H ~ 500keV), shinethrough studies and validation

JT-60SA Advanced Superconducting Tokamak BA-Satellite Tokamak Program

	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)**

IC: Machine inspection after the first disruption at ~2MA

Note: *Easter Sunday, 28/03*

- T&C/PEP experiments should follow IC pulses
- **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]

Cycle #2: H → D changeover, I_p < 3MA

H-D mixture with evolving H/(H+D); P-NBI (D) = 13.5MW; N-NBI (H) = 10MW

	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*				$S_{P\text{-}NBI}(D)$ ~ 1.3×10^{21} el/s $S_{N\text{-}NBI}(H)$ ~ 1.3×10^{20} el/s
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.]	Target: **H/(H+D) < 15%**

- **<u>Major highlights</u>:** 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]

Note: Golden Week, 29/04 – 05/05

Cycle #3: Deuterium plasma, I_p < 3MA

Deuterium plasma with H/(H+D) < 15%; P-NBI (D) = 13.5MW; N-NBI (H) = 10MW

JT-60SA Advanced Superconducting Tokamak BA-Satellite Tokamak Program

	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

Decision point for Cycle #4: keep N-NBI with Hydrogen or switch to Deuterium

- Check if we can achieve I_p ~ 4MA plasmas with 15kA CS → risk mitigation option for Cycle #4, [M04] and [M05]
- **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]

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

Two options: decision to be taken at the end of week #3 in Cycle #3

JT-60SA Advanced Superconducting Tokamak BA-Satellite Tokamak Program

Note: Weekly neutron budget = 3.1×10^{18}

Option #1 (preferred): **change of N-NBI to deuterium** ($Y_n \sim 5 \times 10^{16}$ 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), $\Delta t \sim 5$s * High-power gyrotron test (> 1MW/unit inj.)
Week #3 [22/06 – 25/06]	* M01: H-mode at $I_p \sim 4$MA [+ W-TESPEL test] * M02 & M08: Shinethrough and fast ions (L-mode) * M04: High-current L-mode, $I_p \sim 5$MA (evenings)
Week #4 [29/06 – 02/07]	* DSOL studies: M19-M21 (2 days) * EL contingency (M22 & M23 – tbc) (2 days)

Option #2 (backup plan): **keep N-NBI in H until the end of the campaign** ($Y_n \sim 1 \times 10^{16}$ 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 $I_p \sim 4$MA [+ W-TESPEL test] * M04: High-current L-mode, $I_p \sim 5$MA (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]

IC: Machine inspection after the first disruption at $I_p \sim 4$MA and $I_p \sim 5$MA

Weekly neutron budget constraint:
H-mode & L-mode pulses mixed during the day;
H-mode scenario development distributed throughout the week

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