Goals of the meeting and status of European machines in 2027

E. Tsitrone for TE TFL

E. Tsitrone, N. Vianello, Y. Kazakov, A. Hakola, V. Igochine, D. Keeling, B. Labit, V. K. Zotta

Many thanks to machine representatives for their input :
S. Coda, P. Maget, T. Puetterich

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Introduction : the WP TE programme for 2027

2027 : continuity in the WP TE objectives but streamlining the programme

2026-2027 conceived as a 2 years programme

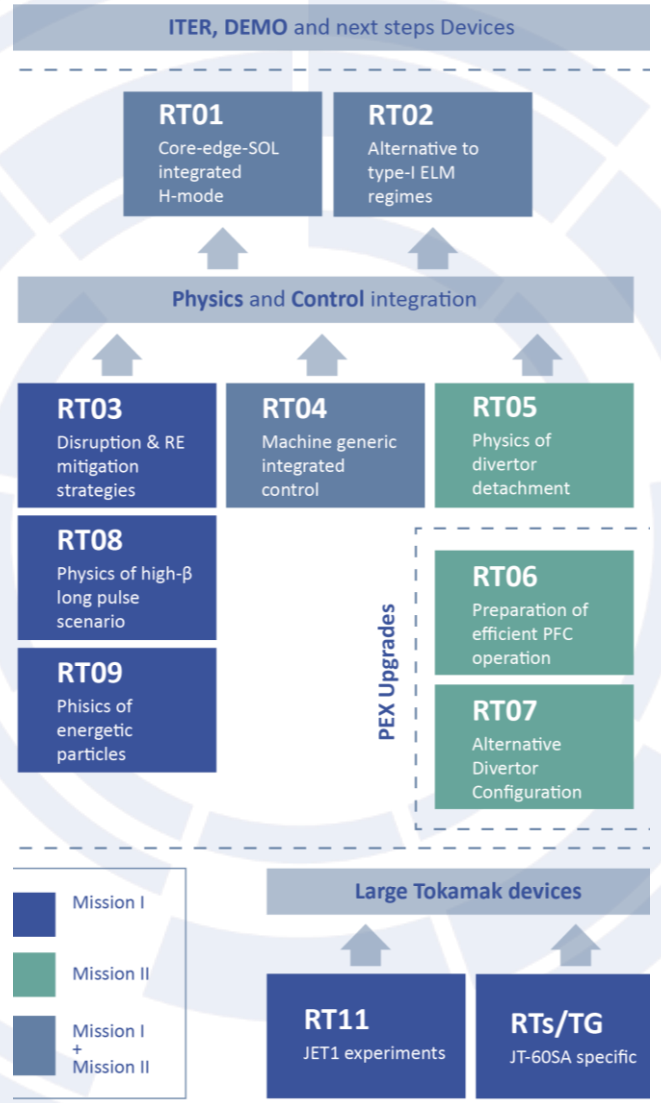
- A unique call for experimental proposals covering 2026 and 2027 for AUG, MAST-U, TCV, WEST : used as basis for discussion today
- 2 yearly calls for participation

High Level objectives for 2027

- Address urgent R&D issues related to the new ITER baseline / Research Plan (full tungsten wall) → ITER MoU
- Provide qualification of the most promising no-ELM scenario (focus = XPR and QCE, applicable to both ITER and FPP)
- Support modelling efforts for interpretation of available data from TE devices
- Run the JT-60SA OP2 campaign and work towards W transition of JT-60SA

Guiding principles for streamlining the programme :

- Revise 2027 shot allocation taking into account 2026 achievements / priorities for ITER MoU / Grant deliverables
- Focus on items close to completion
- Decreasing JET activities while ramping up JT-60SA effort (NB : 2027 resources for JT-60SA made available at last GA)



Same Research Topic structure for 2027

List of Grant Deliverables 2026-2027

ID	Deliverables Table	Date
TE.D.16	Report on fully integrated simulation of high current partially detached plasma scenario including assessment of PFC erosion in D and DT plasma	Dec 2026
TE.D.17	Report on reduced model validation for plasma reattachment on multiple devices and wide operational space	Dec 2026
TE.D.18	Report on providing input on design and operation of conditioning systems for next step full W devices and focus on standard boronization systems	Dec 2026 ➔ Jul 2027
TE.D.19	Report on qualification with experiment/modelling of the most promising no-ELM scenario in terms of confinement, exhaust capabilities and plasma wall interaction	Dec 2027
TE.D.20	Report on optimized scheme for "benign termination" of runaway beams documented in view of possible applicability for ITER	Dec 2027

- Strong links expected with WP TM to fulfill the modelling related GD

List of Milestones 2026-2027

ID	Milestones Table	Date
TE.M.09	Proper figure of merit for cross-scenario comparison among no-ELM / ADC defined	Dec 2026 ➔ Jul 2027
TE.M.10	First wall particle and heat fluxes quantified in XPR in metallic devices	Dec 2026
TE.M.11	ADCs characterized in H-mode conditions in all relevant TE devices	Dec 2026
TE.M.12	Modelling of SPI experiment on JET and ASDEX-Upgrade completed	Dec 2027
TE.M.13	Impact of N-NBI on plasma behaviour documented in JT-60SA and extrapolation to ITER investigated	Dec 2027

Tentative shot allocation for 2027 for AUG, TCV and WEST

% of op time	2025	2026	2027
AUG	50	40	27,5
TCV	40	35	27,5
WEST	40	40	27,5

- Programme streamlined to comply with available TE experimental time
- WP TE Project Board informed that additional programme ready to fly, should more time become available

Provisional shot allocation for 2027 *			
RT	ASDEX-U (until summer break)	TCV	WEST
RT01	34	90	15
RT02	35	120	0
RT03	35	110	15
RT04	25	120	30
RT05	25	90	30
RT06	20	0	90
RT07	40	110	0
RT08	25	170	15
RT09	18	120	15
Contingency	64	214	54
Sum	**321**	**1144**	**264**

* : to be revised after GPM

Priorities for JET

- Complete integrated modelling of the ITER baseline high current seeded scenario (RT01)

NB : modelling effort started on QCE (RT02) and XPR (RT05)

- Complete JET SPI data analysis and modelling (+ comparison with AUG SPI) ➔ publication (RT03)

- Support for other activities under RT11 decreasing : focus on a subset of topics, selected based on their strategic relevance to ITER
  - separatrix
  - ICRH scheme
  - isotopic effects, high-current operations and competition between gas and pellet fuelling
  - L-H transition

Experiments selected for JT-60SA OP2 campaign

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

- Experimental time : 60% JA, 40% EU
- 23 experiments selected (10 EU Experiment Coordinators (EC), 13 EU Co EC)
- 6 Seconded National Experts (F4E supported long stay) for WP TE : support to visiting EU scientists for OP2

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)
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M08: Physics of FI-driven instabilities and their impact on the plasma	S. Maz	
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M10: Plasma shape control	S. Inou	
M11: ECRH/ECCD control and impact on sawteeth	E. Ales	
M12: Wall conditioning and isotope exchange monitoring	M. Fuk	
M13: Breakdown and plasma initiation optimisation	N. Tsuj	

OP2 experiment	EC	Co-EC
M14: Characterisation of L-mode transport and confinement	Y. Ohtani (QST)	T. Tala (VTT)
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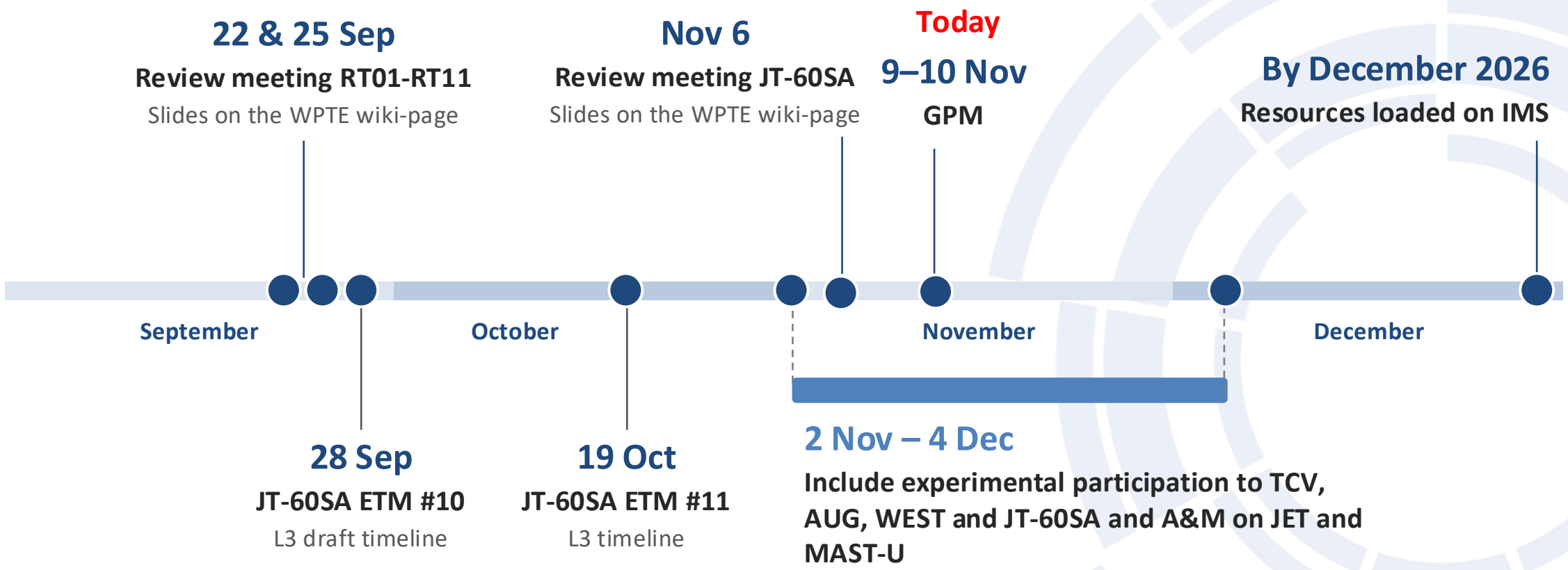
M17: Pedestal and ELM characterisation	L. Frassinetti (KTH)	M. Akimitsu (QST)
M18: Tungsten transport studies in support of JT-60SA W-PFC transition	T. Kawate (QST)	P. Manas (CEA)
M19: Heat flux decay length parametrisation in high-current H-mode	G. Rubino (ISTP-CNR)	R. Matoike (QST)
M20: Impact of divertor 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)

Steps for preparing the WP TE 2027 programme



- **Call for participation deadline : December 4**
- Staffing selection by WP TE TFL by December 2026
- Strategy meetings by RTC in January 2027

Specific case : applying for JT-60SA OP2 activities

22 & 25 Sep
Review meeting RT01-RT11
Slides on the WPTE wiki-page

Nov 6
Review meeting JT-60SA
Slides on the WPTE wiki-page

Today
9–10 Nov
GPM

By December 2026
Resources loaded on IMS



28 Sep
JT-60SA ETM #10
L3 draft timeline

19 Oct
JT-60SA ETM #11
L3 timeline

2 Nov – 4 Dec
Include experimental participation to TCV, AUG, WEST and JT-60SA and A&M on JET and MAST-U

WP TE staffing selection for OP2

WP TE will forward participation to JT-60SA project call for TE selected OP2 participants

Last name	First name	Email	Affiliation	Workplan including contribution to experiment deliverables

29 Oct-29 Dec
JT-60SA project : Call for participation in OP2 Experimental Campaign (for EU and JA participants)

https://www.jt60sa.org/wp/call-for-participation-in-op2-experimental-campaign/

Reminder : anybody interested in JT-60SA activities should apply to the JT-60SA Experiment Team

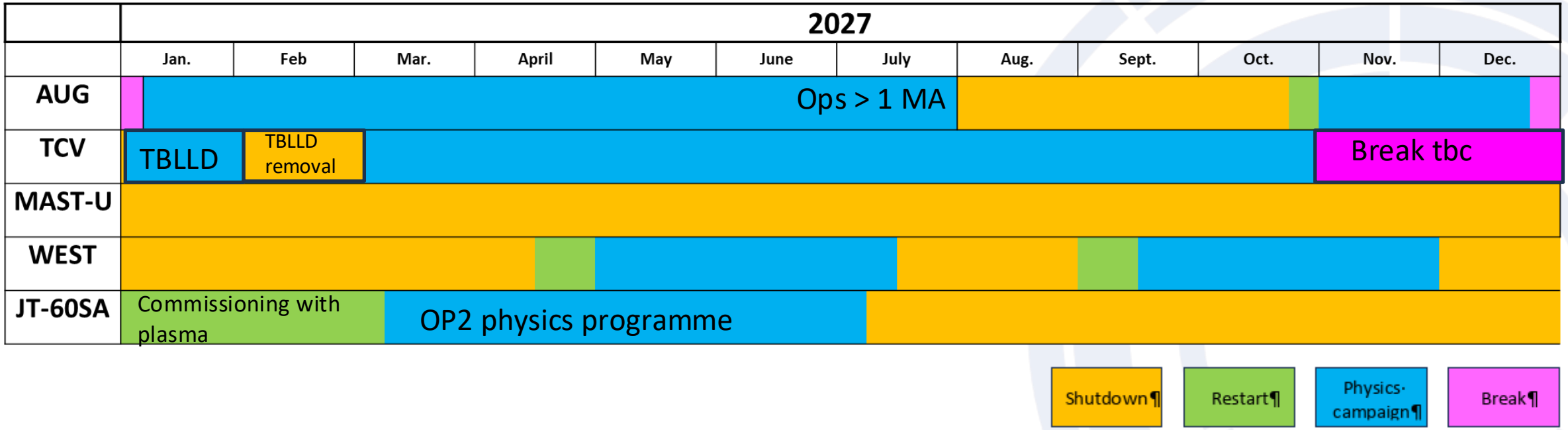
Machine status for 2027

For more information on AUG, MAST-U, TCV, WEST:

- Check WP TE wiki devices pages : https://wiki.euro-fusion.org/wiki/WPTE_wikipages:_WPTE_devices
- Previous 2025 GPM machine status slides : https://wiki.euro-fusion.org/wiki/WPTE_wikipages:_Meetings:_Meetings2025#TE_General_Programme_Meeting_04th_-06th_November_2025

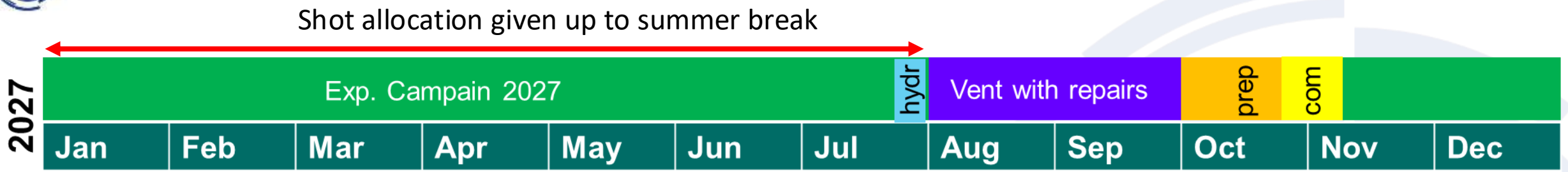
Focus on JT-60SA in next talk

2027 WPTE programme at a glance



- AUG : operation at high current end of campaign , high power requiring strike point sweeping
- TCV : back to full power in January, TBLLD phase extended, shutdown to remove TBLLD in Feb
- MAST-U : not in operation in 2027
- WEST : ECRH now operational, 3 gyrotrons expected end 2027
- New TE ENH becoming operational : UFR on AUG, REMC on TCV, LIBS on WEST …
- JT-60SA : start of OP2 physics programme expected in March, OP2 campaign extended until June

AUG in 2027

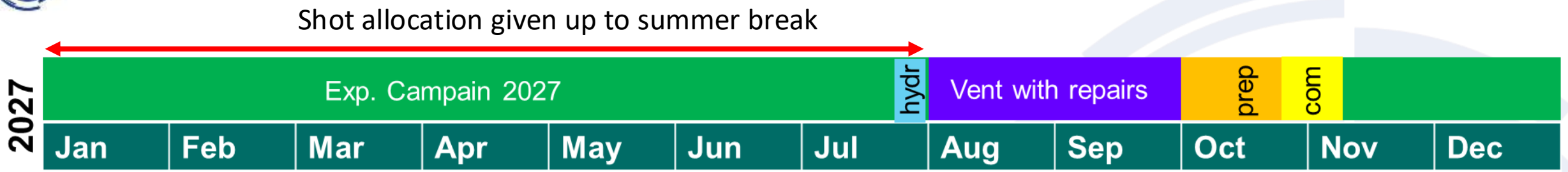




- New upper divertor diagnostics fully operational including upper divertor Thomson scattering
  - Thomson scattering in lower divertor is scarce resource => 2 week-block planned in March
- Upper cryo-pump better understood, but issues can only be mitigated and not be fully resolved
- Upper GPI diagnostic at low densities
- Dispersion interferometer and MANTIS available
- **ECRH:** 6 gyrotrons until Feb/Mar 2027, then 7 gyrotrons (4.5-5.5MW)
  - end of 2027 possibly 8 gyrotrons => 5.5-6MW
- **ICRH:** 2027: new generator enables 6MW total power + additionally 24MHz @ <2MW (Capabilities will be enabled over time)
- **B_t=3.5T** possible with short flattop time (max flattop in Bt ~3s), commissioning in plasma pulse neccessary

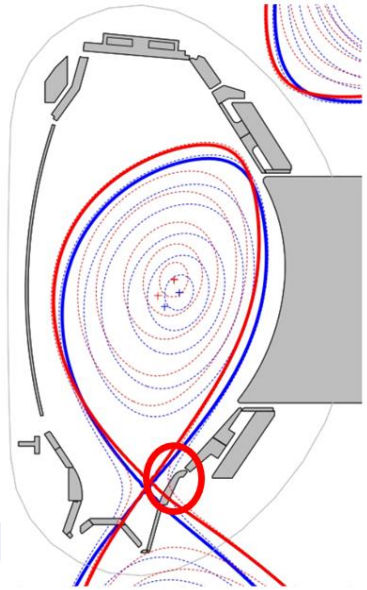
[Courtesy T. Puetterich]

AUG in 2027



Machine Risk Management :

- Excessive disruption force broke divertor tiles in 2025 : high Ip (> 1 MA) operation at the end of the campaign
- Focussed heat loads cause cracks in W tiles – not catastrophic but should be minimized : strike point sweeping for Paux- Prad > 7.5MW
- During fall campaign startup, bad thermal contact of tile in lower divertor found : up to now not limiting, but problematic for NT



AUG operation presently suspended for ~2 weeks (cf message from T. Puetterich last Friday) :

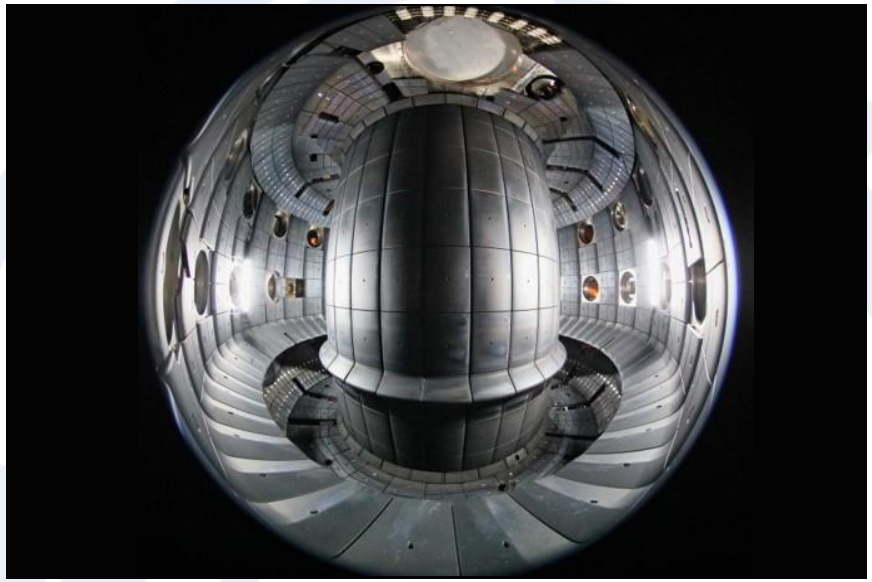
- Impact on timeline of the 2026 fall campaign / 2027 programme will need further assessment

[Courtesy T. Puetterich]

TCV in 2027

Timeline (not all details decided yet – changes are possible)

- January: completion of Tightly-Baffled Long-Legged Divertor campaign with additional NBI and ECRH power
- February: removal of TBLLD
- March-October: continuous operation with possible breaks for baffle changes (to be agreed between the WPTE and internal programmes)
- November-December: break for major infrastructure work (upgrade of water distribution)



Main features:

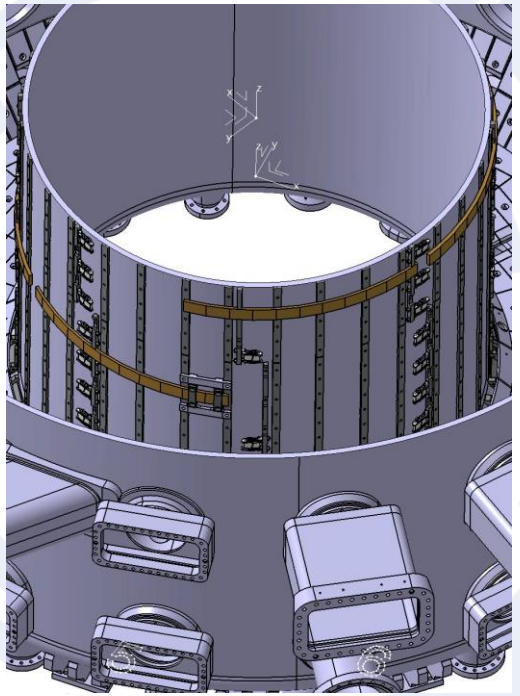
- ECRH: 1 (now) ➔ 4 (by end 2027) 1-MW dual-frequency gyrotrons, with individual real-time steerable launchers
  - lateral for X2, vertical for X3
  - 2nd gyrotron: January; 3rd: ~September; 4th: ~November
- NBI: 2x 1.3-MW counter-directed injectors, 15-25 and 50-60 keV respectively (1 operational, 1 under repair for January)
- 10 gas valves + MGI
- Distributed digital control system

[Courtesy S. Coda]

TCV in 2027

Major new additions :

- Additional auxiliary heating (see previous slide)
- Runaway Electron Mitigation Coil (REMC)
- New power supply for diagnostic neutral beam (higher reliability expected)
- New dual, independent fast power supplies for internal coils
- Toroidal field ripple enhancer for runaway mitigation experiments
- Tomographic DMPX (Duplex Multiwire Proportional X-ray counter) system
- New horizontal reciprocating probe (FReDi)
- Motional Stark effect Spectroscopy (MSS) for current-profile measurements



[Courtesy S. Coda]

WEST in 2027

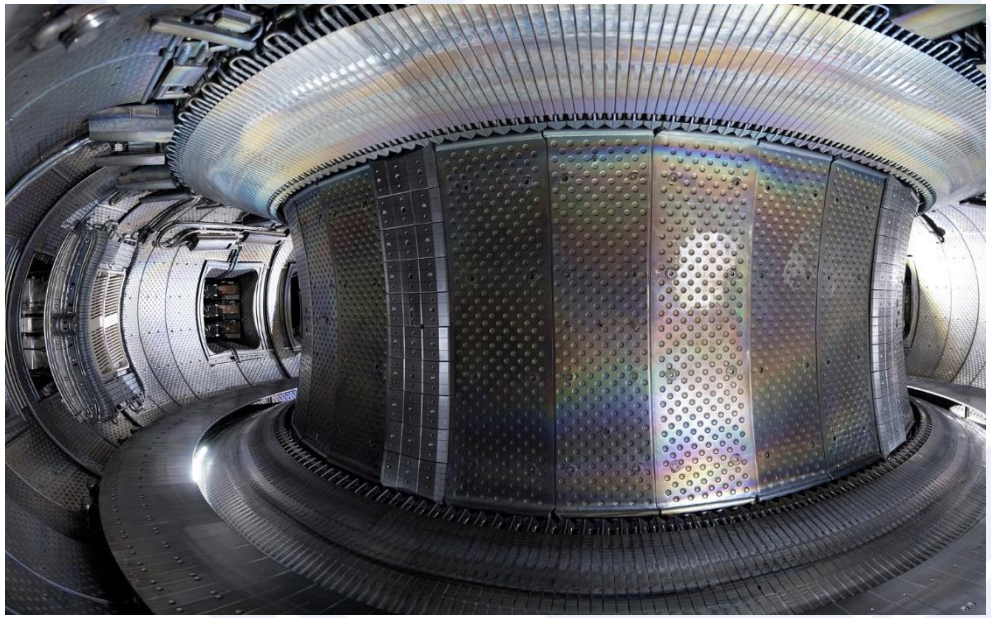
2027											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				C15				C16			

Main features: heating systems

- LHCD system: 2 antennas, ~ 7 MW
- ICRH system: 3 antennas, ~ 6MW
- ECRH system: 2 to 3 gyrotrons (1 MW each) depending on commissioning progress

Main features: fueling systems

- Gas fueling: 11 locations including private divertor region, 3 impurity lines
- Pellet fueling: 4 tracks
- Impurity Powder Dropper



[Courtesy P. Maget]

WEST in 2027

2027											
Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
				C15				C16			

New/upgraded diagnostics

- Thomson diagnostic: edge and core lines of sight, 2 lasers (one in 2026)
- Edge XICS
- Fast infrared camera (FIRCA)
- RFA probes will be operational simultaneously in the divertor and RCP
- Instrumented bulk W tiles for runaway experiments
- Equatorial reciprocating boronisation probe
- LIBS

[Courtesy P. Maget]

For all devices : please comply with local visit rules and plan ahead (WEST, TCV if > 8 days per calendar weeks, JT-60SA …)

Objectives of the meeting

Objective of our meeting : build the 2027 WP TE programme

- Revise priorities and shot allocation for 2027, based on the proposals received for the 2026/2027 call, taking into account progress in 2026 and available machine time
- Provide guidance to TE participants for answering the call for participation for 2027

Please bring in your ideas on :

- Specific technical requirements (machine settings or diagnostics) which will need significant advanced preparation, or which represent unusual machine risks.
- Note that implementation of new controllers (eg for RT04) should be discussed with the local control team of the device involved in advance
- Identify overlaps / synergies / coordination needs between research topics or proposals
- Identify possible gaps in the proposed activities.
- Identify and discuss the strategy and the best timing for the experiments to take place.
- Check that the proposed RT pulse allocation is in line with the discussed/agreed priorities.

Looking forward to lively and constructive discussions

Agenda : day 1

Session 1 : Introduction and machine overviews (chair: N. Vianello)		
E. Tsitrone	Goals of the meeting and status of European machines in 2027 (20'+10')	10:00
Y. Kazakov	JT-60SA: machine status and OP2 priorities (20'+10')	10:30
Session 2 : Edge and PWI (chair: B. Labit)		
N. Vianello	RT05 - programme priorities in 2027 (20'+15')	11:00
A. Hakola	RT07 - programme priorities in 2027 (20'+15')	11:35
Lunch break (12:10-13:40)		
E. Tsitrone	RT06 - programme priorities in 2027 (20'+15')	13:40
Y. Kazakov	RT17 - programme priorities in 2027 (20'+15')	14:15
Coffee break (14:50-15:10)		
Session 3 : fast particles and A&M (chair: V. Igochine)		
Y. Kazakov	RT15 - programme priorities in 2027 (20'+15')	15:10
D. Keeling	RT09 - programme priorities in 2027 (20'+15')	15:45
D. Keeling	RT11 - priorities for JET A&M in 2027 (20'+15')	16:20
F. Imbeaux	RT18 - JT-60SA data validation and data access (10'+10')	16:55
End of day 1 : 17:15		

Agenda : day 2

Session 4 : Scenarios and pedestal (chair: V. K. Zotta)		
N. Vianello	RT01 - programme priorities in 2027 (20'+15')	09:00
B. Labit	RT02 - programme priorities in 2027 (20'+15')	09:35
Coffee break (10:10-10:30)		
Y. Kazakov	RT12 - programme priorities in 2027 (20'+15')	10:30
L. Garzotti	RT14/RT16 - programme priorities in 2027 (20'+15')	11:05
Lunch break (11:40-13:10)		
Session 5 : core and MHD (chair: A. Hakola)		
V. Igochine	RT03 - programme priorities in 2027 (20'+15')	13:10
D. Keeling	RT04 - programme priorities in 2027 (20'+15')	13:45
Coffee break (14:20-14:40)		
V. K. Zotta	RT08 - programme priorities in 2027 (20'+15')	14:40
G. Pucella	RT13 - programme priorities in 2027 (20'+15')	15:15
Session 6 : wrap-up (chair: E. Tsitrone)		
N. Vianello	General discussion and summary of the meeting (10'+15')	15:50
End of day 2 : 16:15		

Back up

WP TE management team for 2027

2 new DTFL joined WP TE in 2026

Role	Name	Beneficiary
Task Force Leader	Emmanuelle Tsitrone	CEA
Task Force Leader	Nicola Vianello	ENEA
Deputy Task Force Leader	V. K. Zotta	ENEA
Deputy Task Force Leader	Antti Hakola	VTT
Deputy Task Force Leader	David Keeling	UKAEA
Deputy Task Force Leader	Y. Kazakov	ERM
Deputy Task Force Leader	Valentin Igochine	MPG
Deputy Task Force Leader	Benoit Labit	EPFL
Project Support Officer	Zeinab Doagouei	MPG

EU Experiment Team Leader for JT-60SA

Team of Research Topic Coordinators (RTC) for 2027

RT				
RT01	Carine Giroud	Lorenzo Frassinetti	Sven Wiesen	Marco Cavedon
RT02	Michael Faitsch	O. Krutkin	Eleonora Viezzer	A. Mariani
RT03	Ondrej Ficker	Cedric Reux	Umar Sheikh	
RT04	Adriano Mele	Gijs Derks	Charles Vincent	Lidia Piron
RT05	Pierre David	Holger Reimerdes	Nicolas Rivals	Stuart Henderson
RT06	Yann Corre	Karl Krieger	A. Kirschner	
RT07	Ou Pan	Olivier Février	Kevin Verhaegh	
RT08	Chiara Piron	Sam Blackmore	Fulvio Auriemma	
RT09	Yevgen Kazakov	Joaquin Galdon	Anton Jensen van Vuuren	Roman Ochoukov

New RTC for 26-27

New RTC selected to replace O. Sauter for RT02 in 2027 : Oleg Krutkin and Alberto Mariani

Reduced operational time in 2027 : lower impact of EUROfusion for ITER and delay for physics basis for FPP

	Scenario I	Scenario II	Scenario IV
ITER scenario with integrated exhaust solution*	de-risk accessibility of seeded enhanced pedestal scenario for ITER Q=10		
Integrated no-ELM scenarios *	assess viability of QCE / XPR, derisk NT operation for DTT / increase confidence for FOAK scenarios		
W control (source, transport, RMP effect modelling)*	increase confidence for W control with RMPs and in long pulse operation (code validation)		
Disruption / RE mitigation + RE impact on W walls*	Robust strategy for RE mitigation and control / provide sound basis for TFW design		
Full W wall conditioning (boronization, startup, etc)*	Ensure reliable machine conditions for ITER operation / provide basis for ITER safety report		
Dataset for full model suite validation (JINTRAC/ SOLPS-ITER wide grid …) *	Expand parameter space explored for validation of ITER/FPP/FOAK tools		
Demonstration of advanced controllers*	Increase confidence for RT control of ITER and FPP		
Steady state scenario development	Ensure compatibility of steady state operation and exhaust constrains for ITER / FPP		
Alternative divertor configuration	Assess exhaust schemes most suitable for FPP and prepare DTT operation		
Improve physics understanding (pedestal, exhaust, fast particle)	Enhance physics understanding to re risk extrapolation to ITER/FPP		

* : part of the ITER-EUROfusion MoU

Color coding : progress in the topic compared to scenario IV

JT-60SA EUROfusion scientific priorities – C and W phase

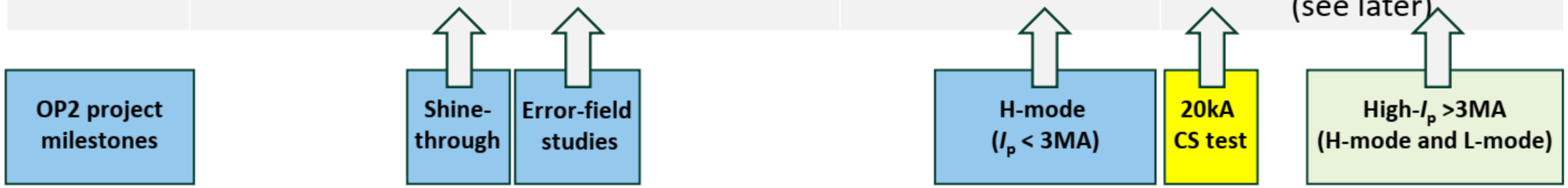
C phase – updated high-priority items	W phase – high priorities (ITER satellite, towards FoaK)
1. Development and investigation of high-performance scenarios compatible with future W-PFCs	1. High-performance, long-pulse, core-edge-compatible scenarios with W-PFCs, including no-ELM regimes, in view of fusion reactors
2. Avoidance and mitigation of disruptions and runaways	2. Disruption-free and safe operation
3. Physics of fast ions and their impact on plasma confinement	3. Power and particle exhaust, including wall conditioning, W source and fuel retention control
4. Development and validation of high-level real-time control strategies	4. Energetic-particle physics in reactor-relevant fast-ion regimes

- FSD initiative, discussed across the FSD WPs (TE, SA, PWIE, TM); STAC feedback included; W phase accepted by STAC
- Communicated to F4E (C phase, May 2026) and the JT-60SA project (W phase); both presented at the 56th GA

338,7 x 190,5 mm

Overview of OP2 campaign

	Cycle #1 (~March 2027)	Cycle #2 (~April 2027)	Cycle #3 (~May 2027)	Cycle #4 (~June 2027)
	Hydrogen plasma	H → D changeover	Deuterium plasma ($I_p \leq 3$MA)	Deuterium plasma (high current, $I_p > 3$MA)
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)



Main OP2 experiments selected

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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)**

European long-term mission experts in support of JT-60SA Experiment Team activities

- Seconded National Experts (SNE) : collaboration scheme between EUROfusion and F4E to support long term stay (> 1 year)
- Selected SNE will support the JT-60SA Experiment Team, including EU visiting scientists

Selected Expert	Task Description	
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	WPTE
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)	WPSA
9. Federico D'ISA (RFX)	Diagnostic Expert (Edge Thomson Scattering)	