PSD Project Board # 08

WPTE: Status summary of 2025

N. Vianello and E. Tsitrone for TE TFL

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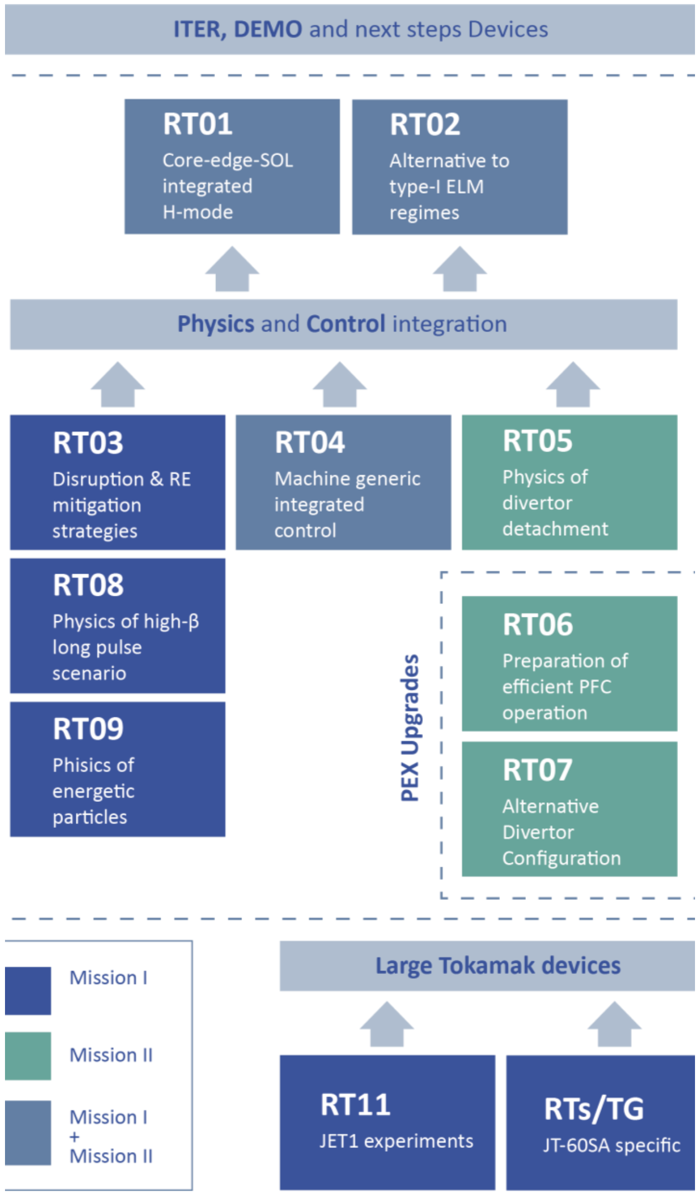
Research Structure kept in continuity during 2024-2025



WPTE framework Based on EUROfusion Road Map:

- **Mission I**: Plasma Regimes of Operation (and fusion technology)
- **Mission II**: Heat exhaust solutions

- Use available European tokamaks (**AUG, TCV, WEST, MAST-U**) and past experiments (**JET**) to advance ITER and Pilot Plant design
- Research Topics (01-09) to address specific Scientific Objectives with a staged integration and cross-device approach
- RT-11 dedicated to JET analysis from previous research programmes
- RT12-RT18 Mapping the JT-60SA Topical Groups: EU Topical Group Leaders acting as well as Research Topic Coordinator in view of ensuring EU coordination

Research Topic Scientific Objectives:

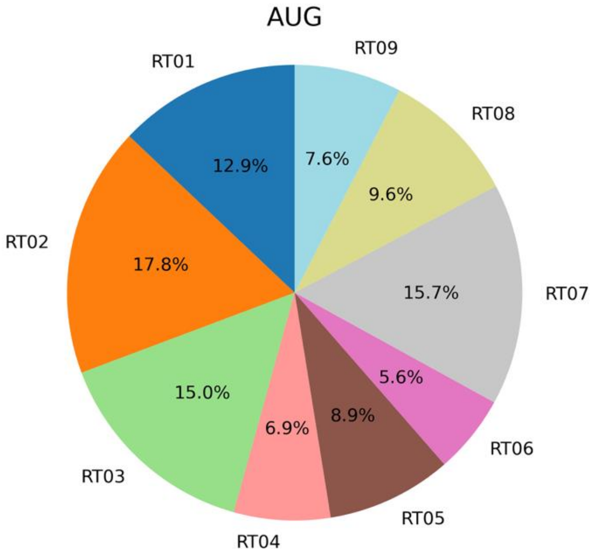
- Established in 2022 with minor evolution throughout the years: broad enough to justify long-term endeavour
- Progress in Scientific Understanding monitored via evolution of Scientific Readiness Levels

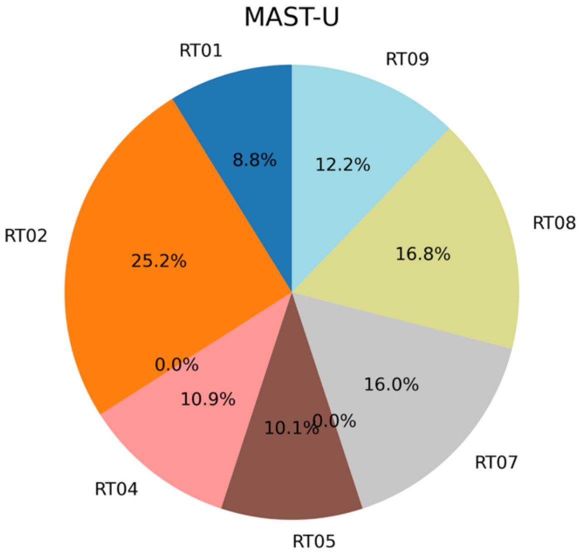
2025 WPTE programme at a glance

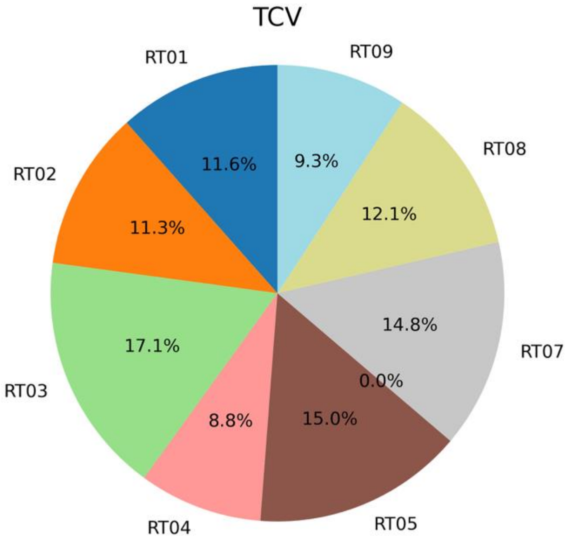
	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
AUG												
TCV					NINO						SILO	
MAST-U							MU04					MU05
WEST			C11								C12	

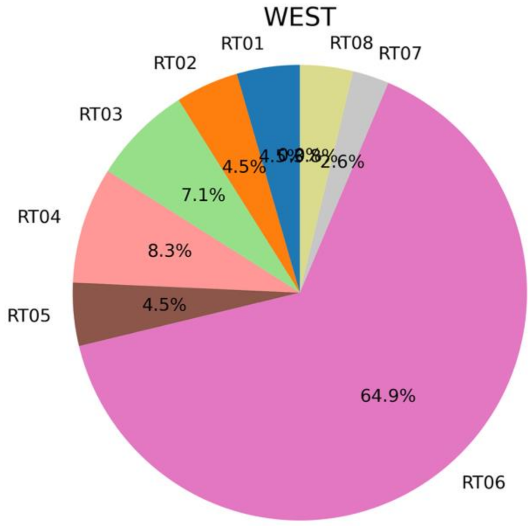
- WPTE run consistently in all 4 European devices in 2025
- Several months with coordinated programs spanning 3 devices simultaneously

2025 Executed shots: Planned vs Executed





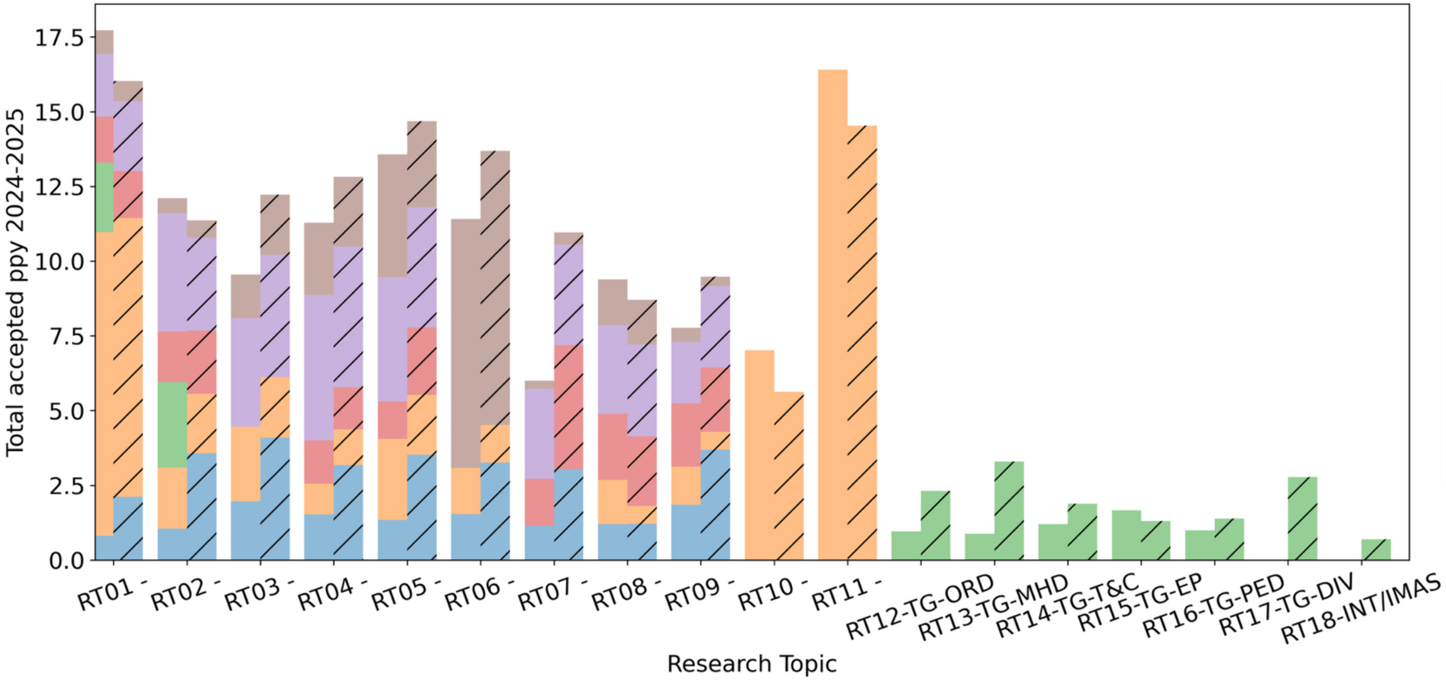




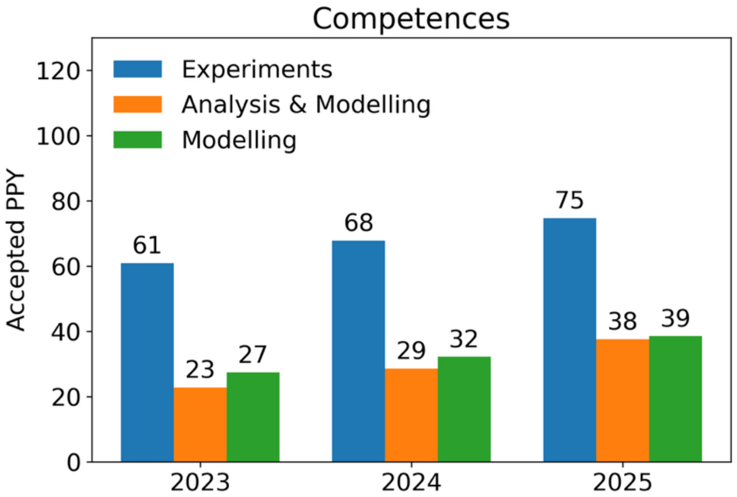
- WPTE Devices used in a complementary approach, taking advantage of the single machine capabilities
- Large fraction of WEST experimental time dedicated to the High Fluence campaign

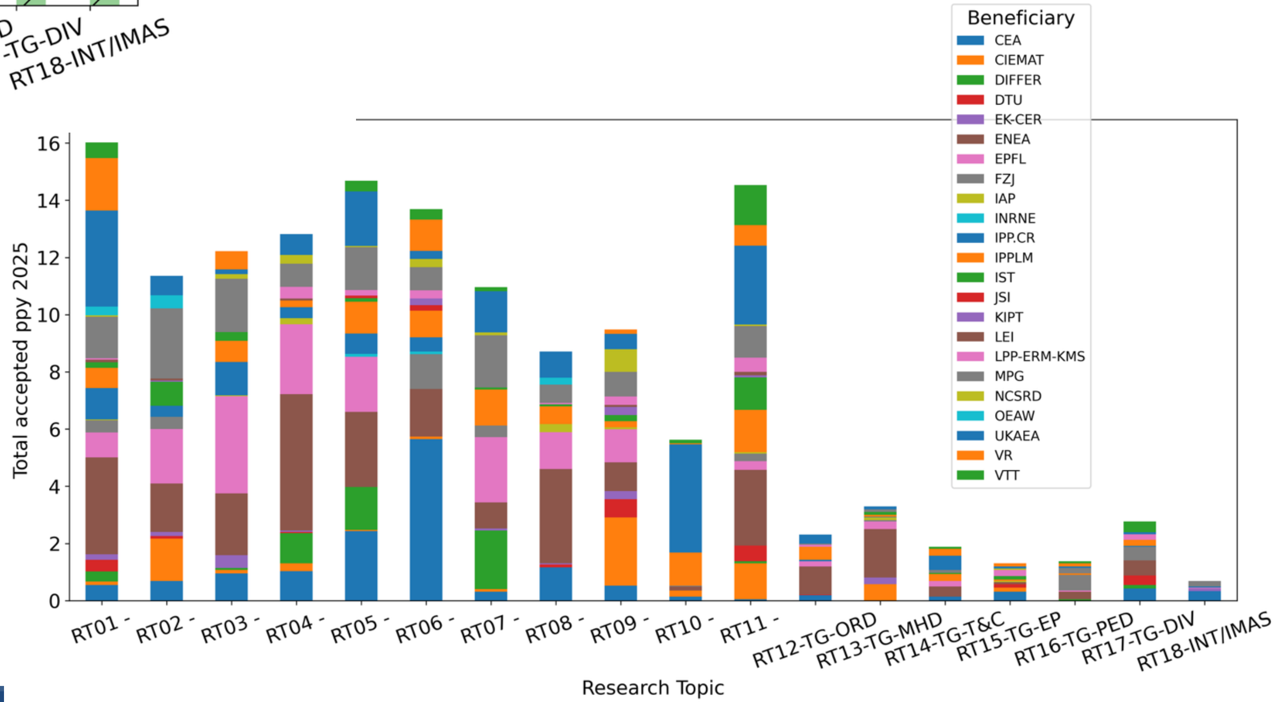
	AUG		TCV		MAST-U		WEST	
RT	AUG Call	AUG Done	TCV Call	TCV Done	MAST-U Call	MAST-U Done	WEST Call	WEST Done
RT01	30	51	120	125	24	21	15	19
RT02	45	70	120	122	48	60	15	19
RT03	60	59	120	185			30	30
RT04	50	27	60	95	32	26	15	35
RT05	35	35	150	162	32	24	15	19
RT06	30	22					180	275
RT07	120	62	170	160	48	38	15	11
RT08	50	38	200	131	48	40	15	16
RT09	30	30	100	100	40	29		
Total	450	394	1040	1080	272	238	300	424

Resource distribution & Missions

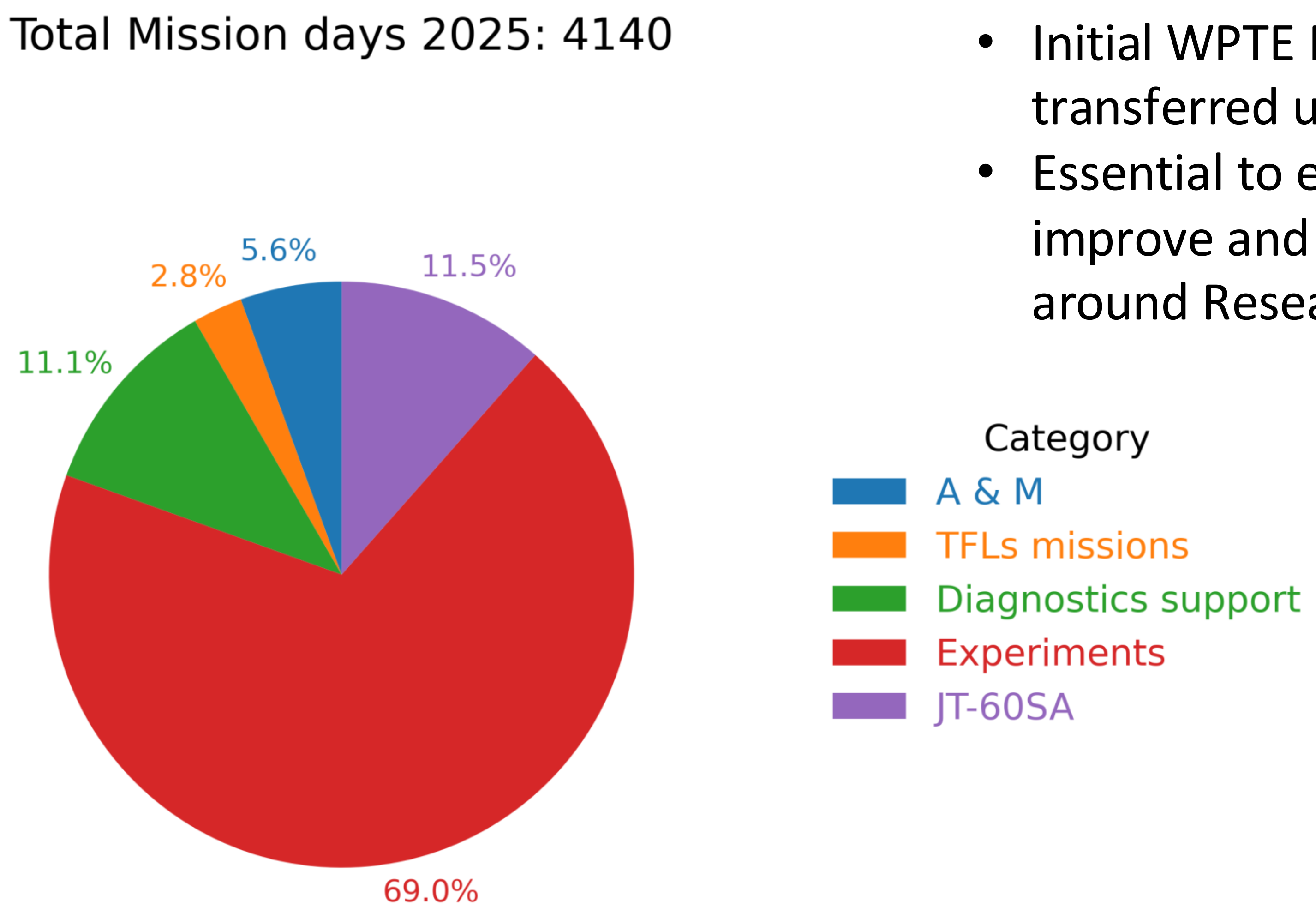


- Overall resources distributed in 2025 (hatched bars) higher than in 2024 with consistent interest towards JT-60SA as new machine
- Throughout the years we continued to increase the resources on all the main competences including interpretative modelling





Mission budget distribution



- Initial WPTE Mission budget increased primarily transferred unused Secondment and INCO budget
- Essential to ensure access to EU labs as well to improve and reinforce pan-European team built around Research Topics

List of GD achieved in 2025

"Title" in Sygma	Title in CWP	Initial due Date	Expected deliverable date	
TE.D.09	Establishment and comparison of N and Ne-seeded partially-detached divertor in high-power operations in view of ITER radiative scenario.	Dec 2023	Dec 2025	Completed
TE.D.12	The physics basis for the decision for an alternative divertor configuration for DEMO.	Dec. 2024	Dec 2025	Completed
TE.D.13	Recommendation on the seeding impurity mix in view of a future reactor.	Dec. 2024	Dec 2025	Completed

- All the expected Grant Deliverables with due date in 2025 were achieved
- Key physics ingredients identified for:
  - Main differences between N and Ne seeded for partial detachment in view of ITER
  - Use of impurity mixes as viable solution for potential reactor scenarios
  - Qualification of different ADC solutions and main physics ingredient leading to better exhaust capabilities
- TE International supported activities provided input to the achievement of INCO GD
- With these, **all the established GD, set at the beginning of FP9 were met, proving robustness in WPTE capabilities to deliver what expected**

Advances in Subjective scientific Readiness Level, WP TE 2025 Campaign

Level	Emerging	Exploratory	Judgemental	Mature-needs underpinning	Mature-needs support	Established

RT	*Title*	*D1*	*D2*	*D3*	*D4*	*D5*	*D6*	*D7*
RT01	Core-Edge-SOL integrated H-mode scenario compatible with exhaust constraints in support of ITER	X				X		
RT02	Physics understanding of alternatives to Type-I ELM regime				X		X	
RT03	Strategies for disruption and run-away mitigation		X					X
RT04	Physics-based machine generic systems for an integrated control of plasma discharge		X			X		
RT05	Physics of divertor detachment and its control for ITER, DEMO and HELIAS operation							
RT06	Preparation of efficient Plasma Facing Components (PFC) operation for ITER, DEMO and HELIAS		X					
RT07	Physics understanding of alternative divertor configurations as risk mitigation for DEMO				X			
RT08	Physics and operational basis for high beta long pulse scenarios		X	X				
RT09	Physics understanding of energetics particles confinement and their interplay with thermal plasma				X	X		

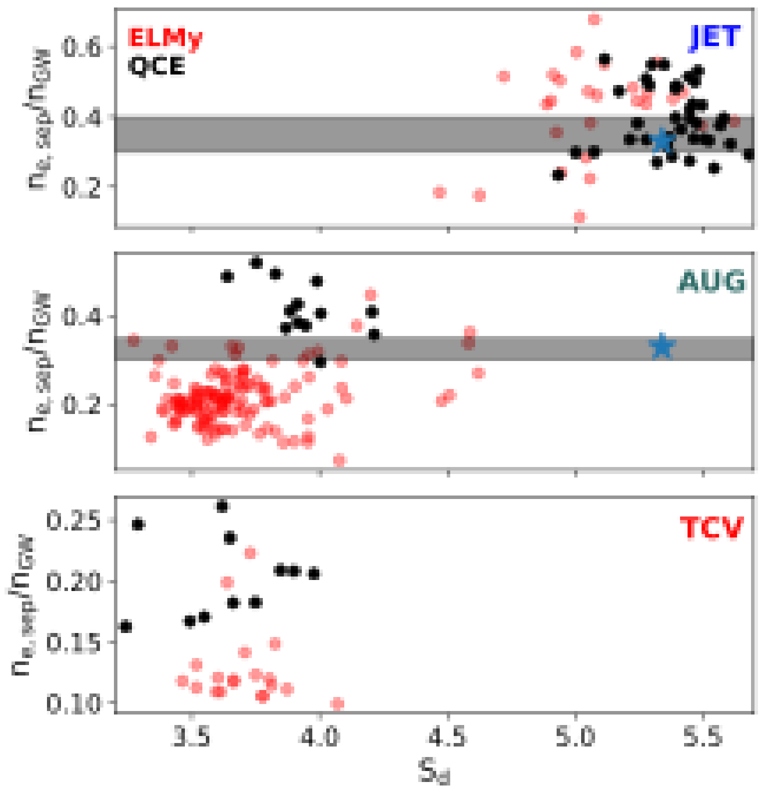
- Progresses in Scientific Objectives monitored via SSRL. Continuous progress throughout the years with most reaching maturity levels. Non uniform progresses among SSRL with expected slower progresses among different maturity levels
- Further progresses, in lower maturity SSRL will benefit for future exploitation on JT-60SA

Scientific Highlight

RT-02: Physics understanding of alternatives to Type-I ELM regime– Extrpolating QCE scenario to ITER

- Quasi-Continuous Exhaust regime (JET, AUG, TCV):
  - Progress in developing access models based on ideal-MHD and importance of transport via ballooning modes
  - Normalised pedestal values combined with predicted minimum separatrix density to reach QCE hightlight the relevance of this regime for the 15 MA ITER baseline scenario.

- ELM suppression with RMP (n=3) in LSN demonstrated for the first time in MAST-U

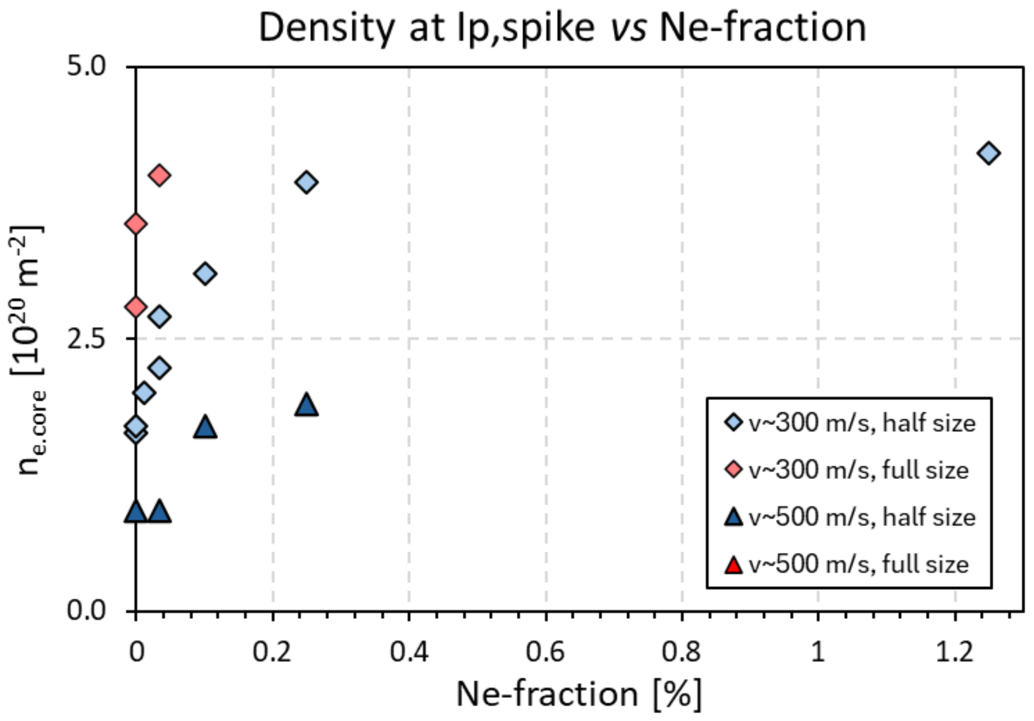


M. Dunne et al, submitted to NF

RT03 - Strategies for disruption and run-away mitigation. AUG-SPI: Test of ITER-like injection schemes

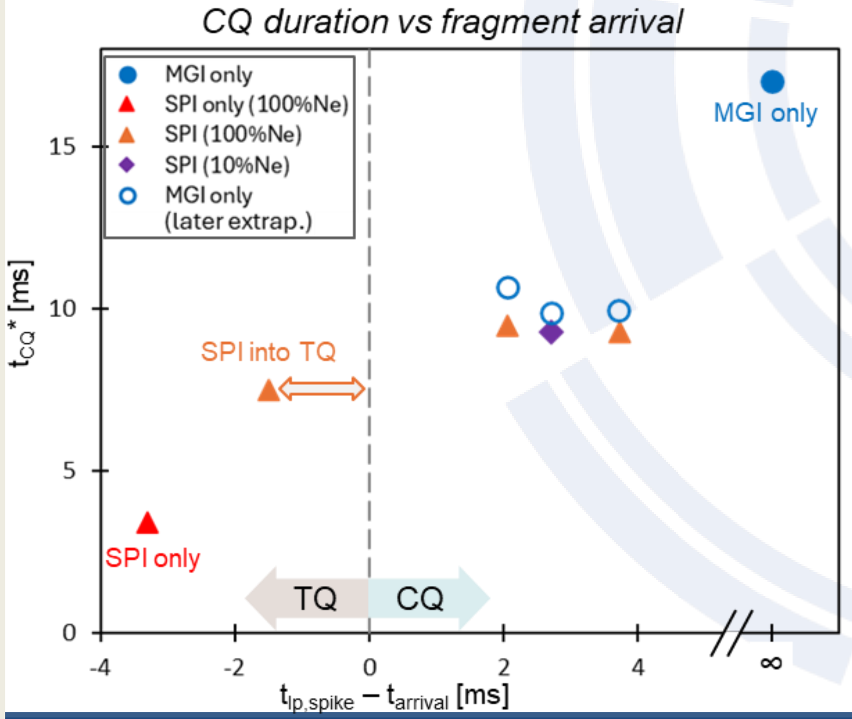
Injection *before* TQ-onset:

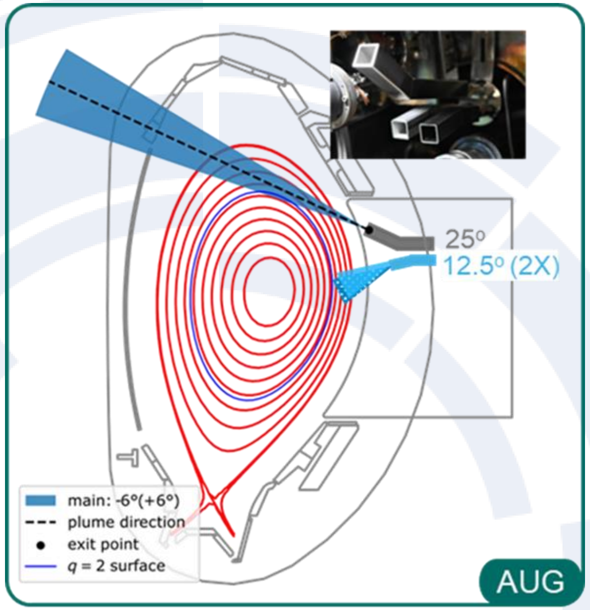
- Better assimilation with increasing Ne-fraction (injection duration still shorter than pre-TQ)
- Initial density rise of fast pellets higher, but loss until CQ onset larger (→ more edge deposition)

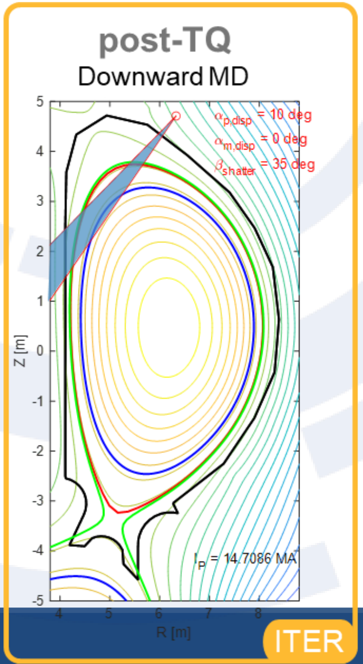


Injection *after* TQ-onset:

- Geometry and shattering similar to ITER (c.f. blue fragment cone)
- SPI into density limit disruption
- Assimilation expected to be low
- CQ control for electromagnetic load mitigation still possible, but large Ne-fractions are required

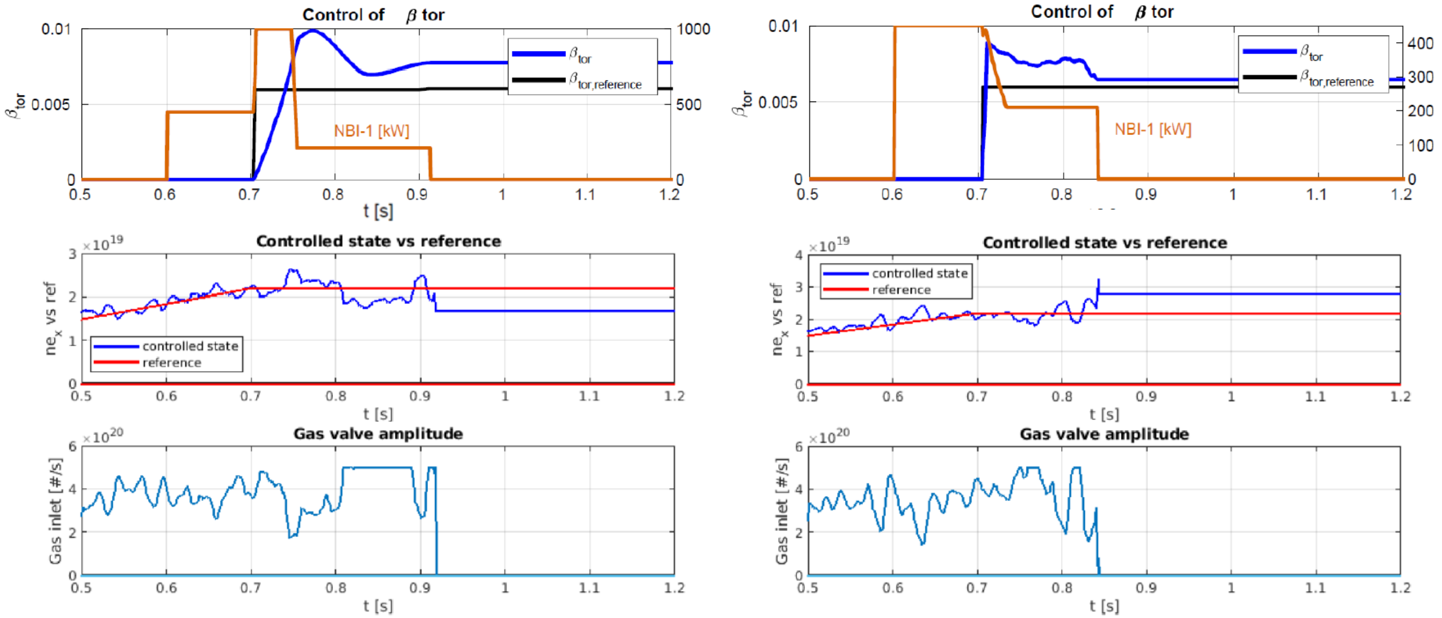






RT-04: Physics-based machine generic systems for an integrated control of plasma. Orchestration of multiple controller

- 87784 vs 87785: simultaneous control of $n_e(\rho = 0.90)$ and β_{tor}



- Activities on plasma controller moved from deployment of single controller towards **orchestration of multiple controller**
- Successful demonstration of a first comprehensive tool for actuators handling (e.g. simultaneous beta and density control or Optimized ramp-down trajectories for soft landing and NTM preemption) and one single monitoring system, based on SAMONE framework.

- Deployment of tools for breakdown and ramp-up optimization on several devices and experimentally validated in particularly on TCV and on MAST-U. (Example: shape control with fast Ip ramp on MAST-U)

RT-06 Preparation of efficient Plasma Facing Components (PFC) operation for ITER, DEMO and HELIAS: new high fluence campaign run under cold divertor conditions at WEST

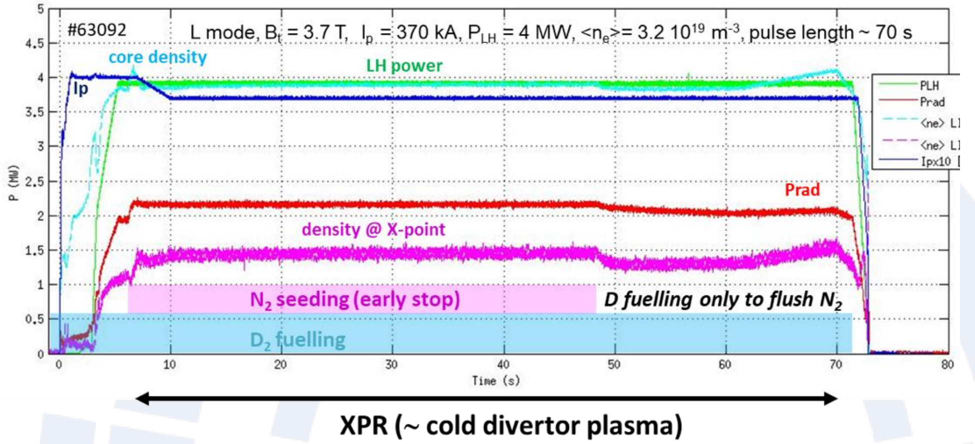
- Objective : test ITER grade divertor components behaviour under high particle fluence for cold plasma conditions (T_e~5 eV, C12 campaign, 2025) for comparison with hot divertor conditions (T_e ~20 eV, C7 campaign, 2023), prone to W erosion

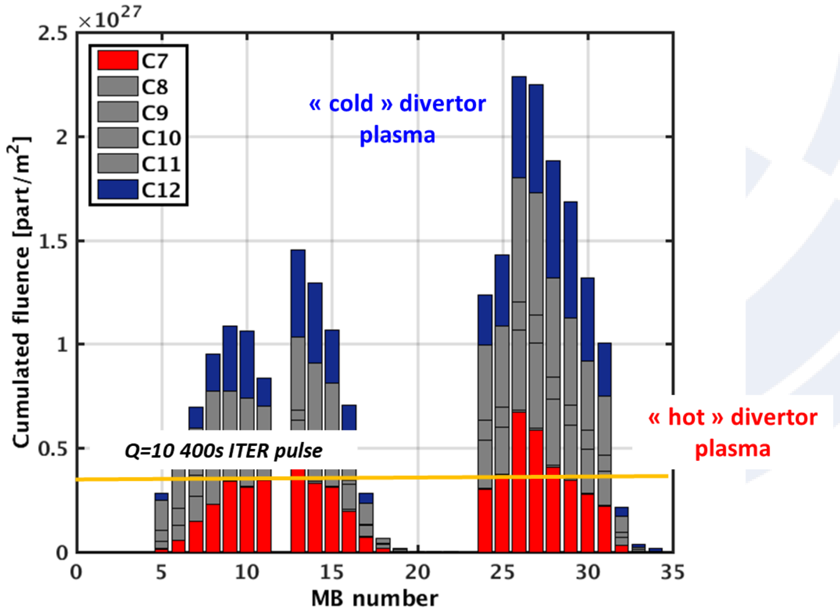
- Repetitive ~1 minute highly radiative shots run over 1 month (N_2 seeding, based on XPR scenario developed under RT05), shared between TE and internal programme. New record for XPR duration on WEST : 73 s.

- No W ingress events (UFO) observed, in contrast with the previous high fluence campaign where UFO hampered operation.

- Cleaning procedure developed to handle N_2 legacy in the vessel walls (early stop of N_2 seeding while maintaining XPR, cleaning discharges, D fuelled ohmic shots) + fine tuning of ramp down to avoid disruptions while exiting XPR

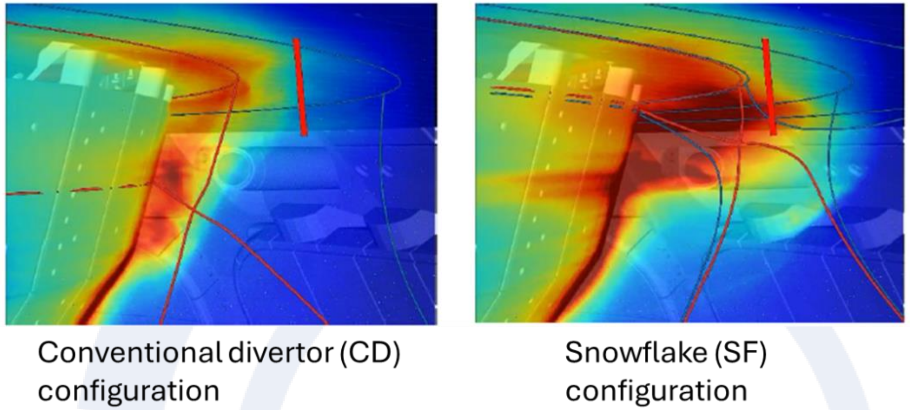
- Visual inspection of divertor post C12 shows different / less pronounced deposition pattern compared to C7 as expected. Post exposure detailed analysis of divertor components starting (WP PWIE)



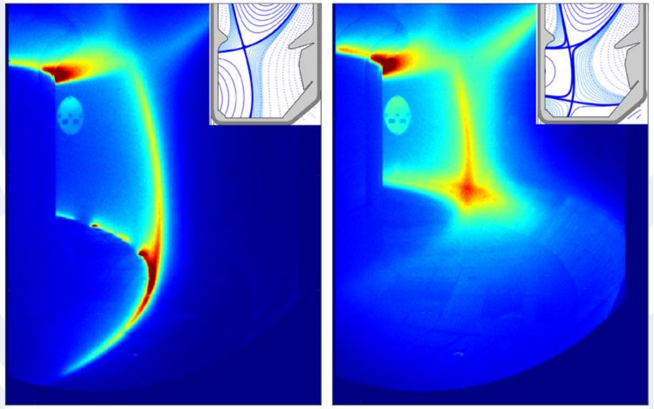


RT-07: Physics understanding of alternative divertor configurations as risk mitigation for DEMO

- Several publications to demonstrate that alternative divertor configurations (ADCs) offer a spectrum of solutions to **enhance power-exhaust performance and can be efficiently controlled**
  - ✓ Can protect the divertor from fast transients, provide earlier access to detachment, wider detachment window, and reduced target power fluxes
  - ✓ Largest benefits obtained in **long-legged ADCs** (especially Super-X) and in certain **ADCs with multiple X points** (e.g., X-point target (XPT))
- Reduced models, e.g., Detachment Location Sensitivity model largely **validated against experimental data** in several ADCs
  - ✓ Multiple pathways exist towards divertor optimization in terms of detachment onset, sensitivity, and window
  - ✓ Baffling can strongly **reduce the escape of neutrals** from the divertor to the SOL
- Advances made in further developing ADCs on contributing devices
  - ✓ **AUG**: all planned ADCs realized and charaterized during the first campaign with the ugraded upper divertor up to power levels of 20 MW
  - ✓ **TCV**: XPT configuration decreases target heat fluxes by >80% (see K. Lee *et al.* Phys. Rev. Lett. **134** (2025) 185102)
  - ✓ **MAST-U and WEST**: independent control of the upper and lower divertor possible in various ADCs



Magnetic equilibrium reconstructions & camera images on AUG for conventional and snowflake configurations



Comparison between the conventional and XPT configurations on TCV: the latter illustrates a strongly radiating X point

Preparation of JT-60SA Scientific Exploitation

- WPTE financed participation to JT-60SA in preparation of OP2
- In view of Experiment Team call for proposals, forum for discussing European flagship and proposed experiment established with dedicated meeting during the GPM and later on-line
- As a long term endeavor, Experiment Team participant, via participation to WPTE RT12-18 working on expected scenarios with W in JT-60SA to guide the definition of heating system
- WPTE financed JT-60SA on-site A&M to strengthen the European involvement
- WPTE TFLs and FSD head participated to ETCM (Experiment Team Coordination Meeting) to clarify the role of JT-60SA in advancement of identified physics gaps.

JT-60SA contribution to present WPTE program

Essential
Beneficial

Area		Research Topics	JT-60SA
ITER Scenario	RT01	Core-Edge-SOL integrated H-mode scenario compatible with exhaust constraints in support of ITER	
ITER Scenario	RT03	Strategies for disruption and run-away mitigation in support of the ITER DMS	Control of run-away & disruption
ITER Scenario	RT04	Physics-based machine generic systems for an integrated control of plasma discharge	Real time control and breakdown
DEMO Scenario	RT08	Physics and operational basis for high beta long pulse scenarios	Target scenario for JT-60SA
DEMO Scenario	RT02	Physics understanding of alternatives to Type-I ELM regime	
Burning plasma	RT09	Physics understanding of energetics particles confinement and their interplay with thermal plasma	Target physics topic for JT-60SA
PEX – Exhaust	RT05	Physics of divertor detachment and its control for ITER, DEMO and HELIAS operation	
PEX – Exhaust	RT07	Physics understanding of alternative divertor configurations as risk mitigation for DEMO	Not applicable
PEX – PFC	RT06	Preparation of efficient Plasma Facing Components (PFC) operation for ITER, DEMO and HELIAS	Not applicable in C environment

Project	Code	PI Name	Jan	May	Sep	Jan.26	Comments
Direct Digital Synthesis for the O-mode Profile Reflectometer at ASDEX Upgrade	AUG: DPR	António Silva	0	0			Project closed at the request of the leading research unit. Significant delay (36k€ equipment in 2025) [Project ends in 2027]
FIRE&GO - Fast Ion Research Enhancements and Gamma-ray Observations [at ASDEX]	AUG: GNS	Massimo Nocente	100	94	88	100	System initially foreseen to be commissioned by June 2026. This should be achieved without significative delays (Summer 2026).
Real-time control system for ELM buffering at ASDEX Upgrade	AUG: RTCS	Michael Komm	88	100	100		Final fine-tunning during campaign. Proposed experiment supported (P1 in 2026)
Real-time spectroscopy at ASDEX Upgrade	AUG: RTS	Marco Cavedon	100	88	100		Project partially completed. EUROfusion project to be stopped by end of 2025 due to budget constraints. Report handed in.
Ultra-fast-swept profile reflectometer on AUG	AUG: UFR	Garrard Conway	100	100	88	81	Expect to have diagnostic operational by April/May. Project ends in 2026.
PFCs and diagnostics for power exhaust studies at COMPASS-U	COMPASS-U: PFC	Miglena Dimitrova	100	94	69	75	Slight delays to Q1 2026. Project still expected to close in 2026.
Tungsten impurity monitoring and control at the COMPASS-U tokamak	COMPASS-U: SXR_IR_ECH	Martin Hron	94	94			Project ends in 2026.
Characterisation of advanced confinement modes at COMPASS-U	COMPASS-U: TS	Petra Bilkova	94	100	81	81	Project ends in 2027.
ONCOMING-Optimized taNgentially spaCe resOlved geM ImagiNG [at MAST-U]	MAST-U: GEM	Andrea Muraro	75	69	69		System installed and operational without He buffer (reduces low energy x ray absorption by air and thus extends sensitivity down to ~1 keV). Project ended in 2025. Report on detector installation, commissioning and preliminary data analysis handed in.
Neutron Detectors suite for 14 MeV neutron triton burnup and 2.5 MeV neutron spectroscopy measurements at MAST Upgrade	MAST-U: NSU	Davide Rigamonti	81	94		94	
Collective Thomson Scattering (CTS) diagnostic for TCV	TCV: CTS	Laurie Porte	88	75	38	56	Delay to the delivery of the gyrotron. Due to delay in receiving new gyrotron the installatoin activities have been delayed but are progressing. EUROfusion project to be stopped by end of 2025 due to budget constraints. Final report was planned for end of 2025.
Upgrade of the TCV ECRH high voltage power supply	TCV: ECRH	Damien Fasel	75	75	75		EUROfusion project stopped by end of 2025 due to budget constraints. Initial conclusion of project in 2027. Report missing.
Implementation of the 4th dual-frequency gyrotron for TCV	TCV: Gyro	Jean-Philippe Hogge	100	100			Project ends in 2027.
Upgrade of the TCV LHPI antenna	TCV: LHPI	Joan Decker	94	31	31		Commissioning first semester 2026. End of project now in 2026 with 3pm and missions (max 9 k€) in 2026.
Runaway Electron Mitigation Coil for TCV	TCV: REMC	Umar Sheikh	100	100	94		Report missing
Runaway electron mitigation and velocity analysis by magnetic-ripple manipulation [at TCV]	TCV: REMR	Alexander Battey	63	100	100		Report missing. Project ended in 2025.
New 100-Hz Laser for the TCV Thomson Scattering System	TCV: TS	Benjamin Vincent	86	50	75	100	Delay is expected to be less than six months.
Boronization Probes for WEST	WEST: BORO	Mathilde Diez	100	92	67	86	Installation and commissioning summer 2026.
Fast Ion Loss Detector in WEST	WEST: FILD	Samuele Mazzi	100	70	70	70	Delays of ~ 6 months
High DEfinition Visible Endoscope for WEST	WEST: HIDEVE	Philippe Moreau	75	75			EUROfusion project to be stopped by end of 2025 due to budget constraints. Final report handed in.
IRBO IR Bolometry for WEST	WEST: IRBO	Pascal Devynck	92	50	36	67	Data validating the prototype will be available around June. Project ends in 2026. Delays due a lack of availability of workshop. Prototype bolometer instalation next opportunity will be campaign in spring 2026.
LIBS4FUSION: in-vessel fuel Inventory and deposited layers composition in a full tungsten device	WEST: LIBS	Arnaud Bultel	69	63	56		Project ends in 2026
A RETARDING FIELD ANALYZER FOR ION TEMPERATURE MEASUREMENTS IN THE SOL OF WEST	WEST: RFA	James Gunn	100	100	88		Report missing

MONITOR BY PMU: Status as reviewed at the beginning of 2026

Replies: Green - score 1; Yellow - score 0.5; Red - score 0

Conclusions

- WPTE program has run reliably over 2025
  - **All FP9 TE Grant deliverables completed**
  - WP TE devices have run reliably and **WPTE Task Force provideed agile organization to adapt to machine conditions**
  - Large number of TE multi machine publications in major journal & fusion conferences (see for instance IAEA FEC 2025 with 2 machine overviews (JET, JT-60SA) and several orals)
- WPTE program demonstrated the capabilities to deliver consistently the objectives and properly use the available resources over FP9
- It provides the framework for establishing a strong pan-European scientific team, allowing consistent multi machine scientific exploitation and enabling access to EU tokamaks for all European beneficiaries

Backup

AI projects to be completed by end of 2025

#	Project Title	PI	Beneficiary
ENEA-03	AI-assisted Causality Detection and Modelling of Plasma Instabilities for Tokamak Disruption Prediction and Control	R. Rossi	ENEA
ENEA-04	Development of Physics Informed Neural Networks (PINNs) for Modelling and Prediction of Data in the Form of Time Series	M. Gelfusa	ENEA
IST-01	Deep Learning for Spectrogram Analysis of Reflectometry Data	J. Vicente	IST

- Reported in TFM https://wiki.euro-fusion.org/wiki/WPTE_wikipages:_Meetings:_Meetings2025#TE_Task_Force_Meeting_09th_June_2025
- No major delays indicated on the agreed deliverables
- Not all the project yet at level of maturity for being deployed to larger community but good progresses reported

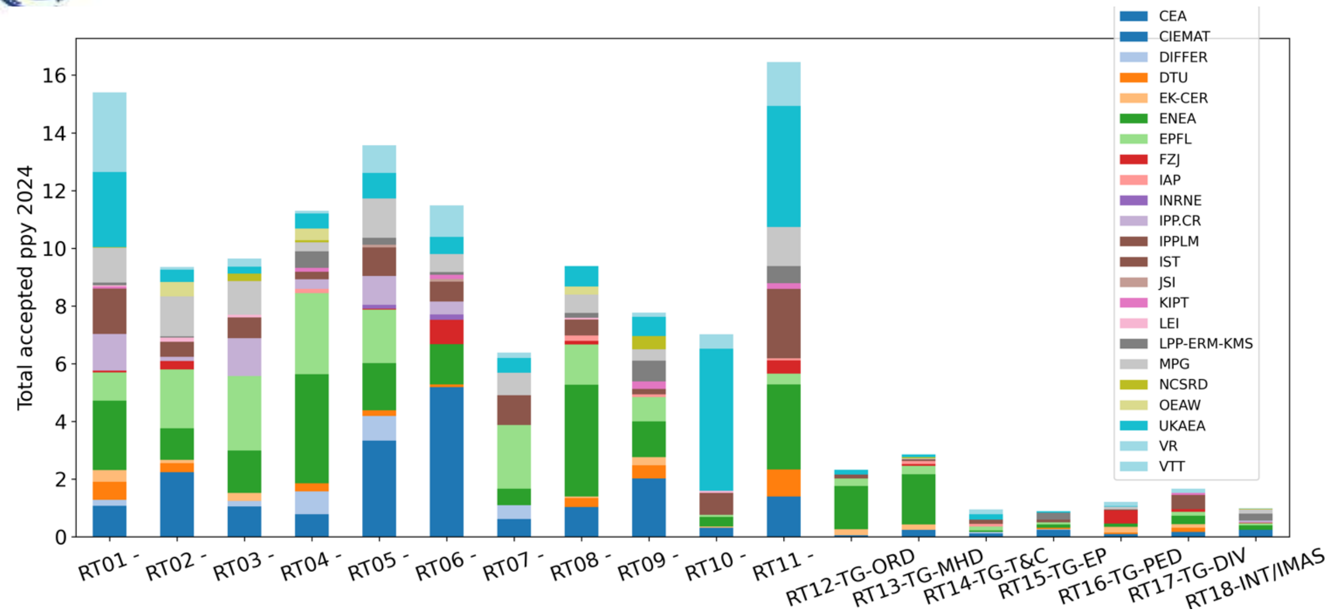
Evolution of SSRL according to 2024 L3 report (now updated since last PB)

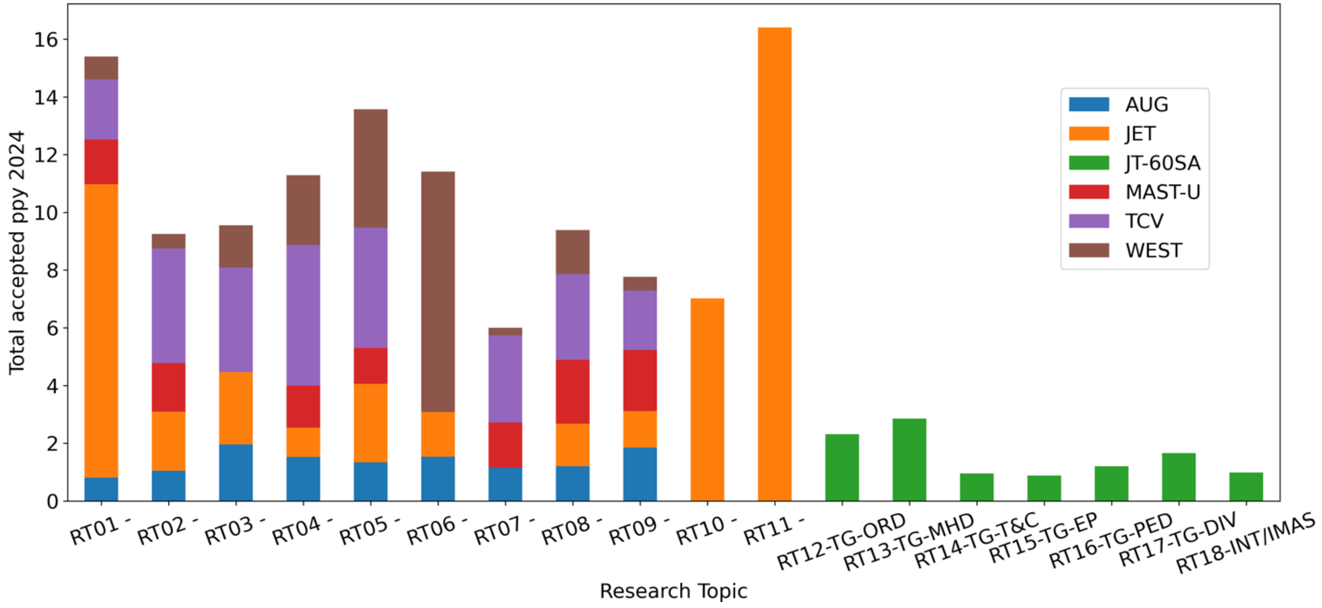
Level	Emerging	Exploratory	Judgemental	Mature-needs underpinning	Mature-needs support	Established

RT	Title	D1	D2	D3	D4	D5	D6	D7
RT01	Core-Edge-SOL integrated H-mode scenario compatible with exhaust constraints in support of ITER		x		x			
RT02	Physics understanding of alternatives to Type-I ELM regime			x	x		x	
RT03	Strategies for disruption and run-away mitigation						x	
RT04	Physics-based machine generic systems for an integrated control of plasma discharge	x	x		x			
RT05	Physics of divertor detachment and its control for ITER, DEMO and HELIAS operation			x				
RT06	Preparation of efficient Plasma Facing Components (PFC) operation for ITER, DEMO and HELIAS		x					
RT07	Physics understanding of alternative divertor configurations as risk mitigation for DEMO			x				
RT08	Physics and operational basis for high beta long pulse scenarios	x		x	x	x		
RT09	Physics understanding of energetics particles confinement and their interplay with thermal plasma		x	x	x			

- “x” indicates progresses in SSRL according to 2024 L3 report

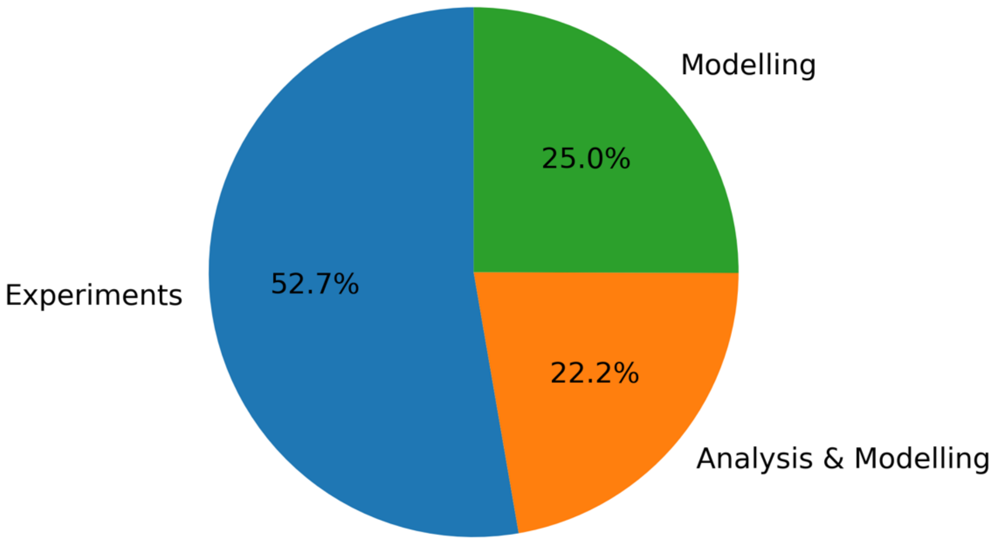
WPTE resource distribution in 2024



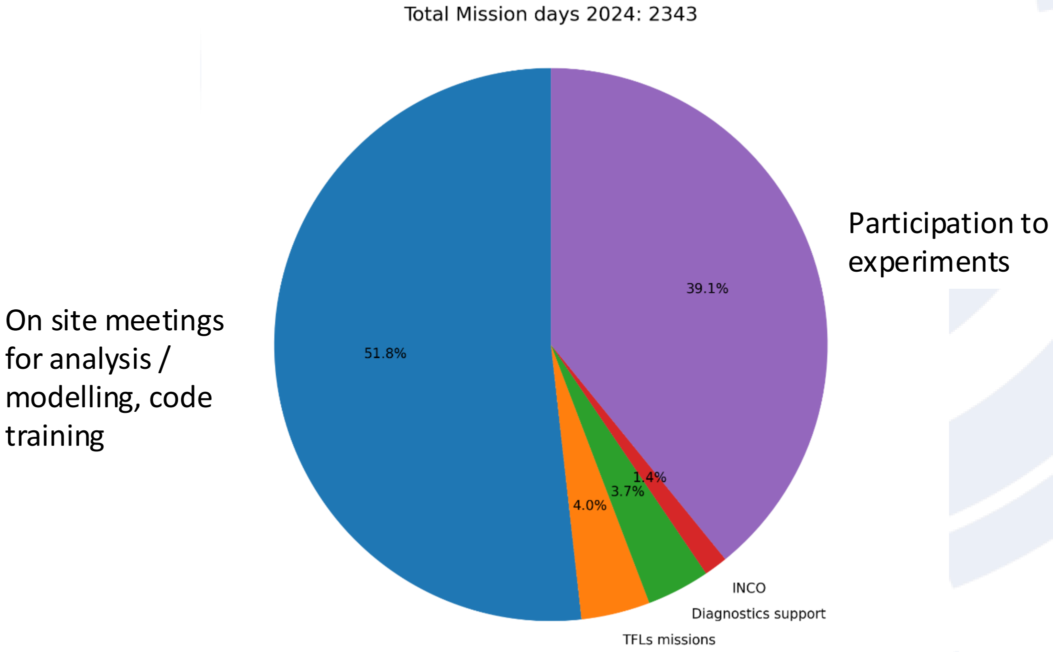


- WPTE : cross-device program with strong contribution by all the EUROfusion beneficiaries (> 600 participants from > 20 labs)
- JET data validation/modelling/scientific exploitation essential in WPTE strategy (significant backlog for data validation)

Increased effort on modelling and mission budget



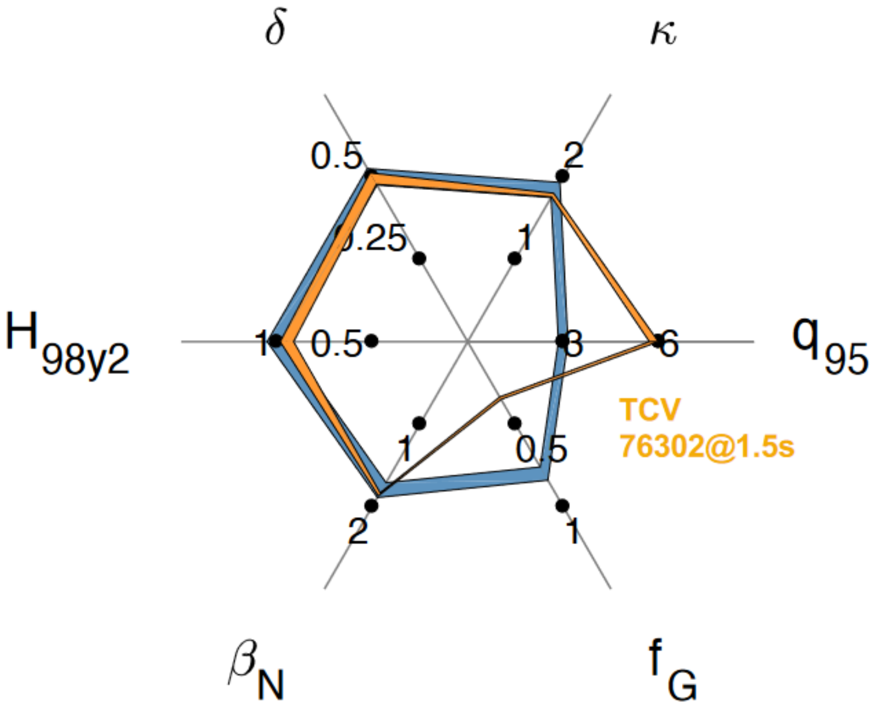
- Significant support to on site participation to TE experiments
- On site meetings for analysis and modelling, code training team building
- Mission support key to build a pan-European Scientific team fostering collaboration among European beneficiaries

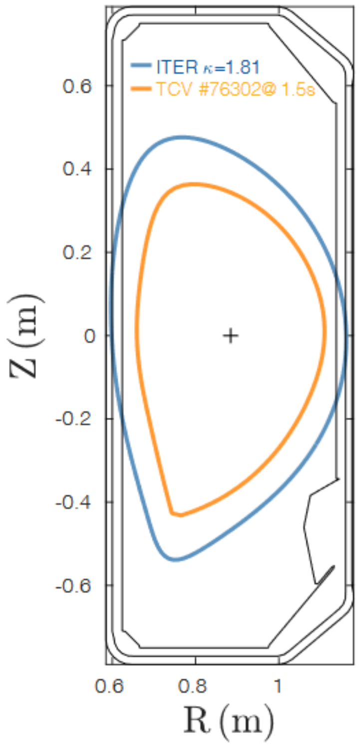


- From 2024 strong increase of effort on modelling (interpretative + extrapolation to ITER/DEMO) started (PCR : additional > 15 ppy granted)

Physics highlight from 2024 Campaigns

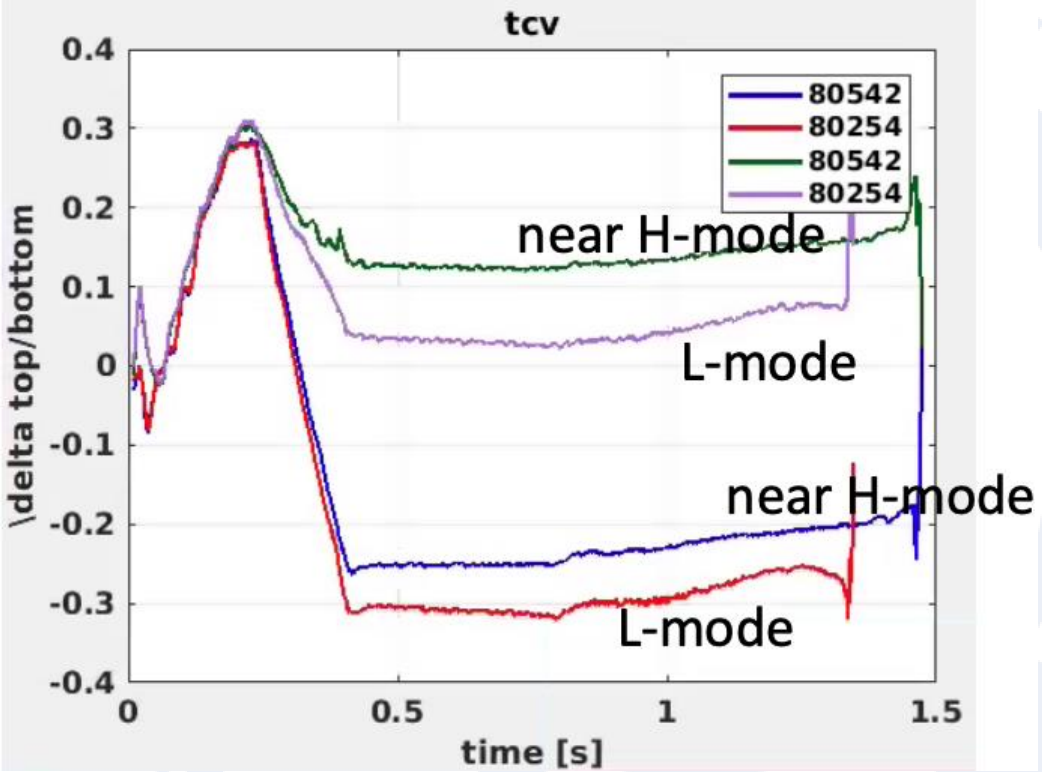
RT01-TCV





- Shaping capabilities of TCV used to reproduce ITER shape: matched at larger q_{95}
- Achieved slighly better confinement than the required ITER target
  - Performance limited by NTM (triggered by an ELM)
- Ramp-down optimization with RAPTOR implemented and optimization ongoing

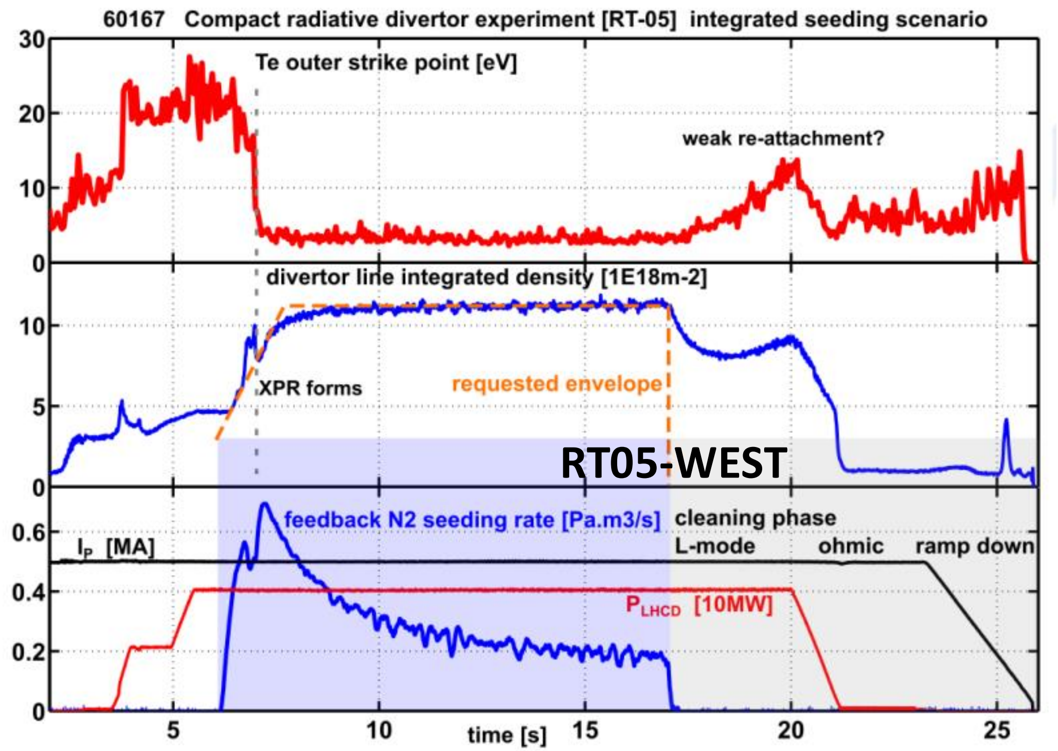
RT02-TCV



- H-mode access at different values of upper **δ** established in TCV for AUG new shape development for 2025

Physics highlight from 2024 campaigns

RT05-WEST



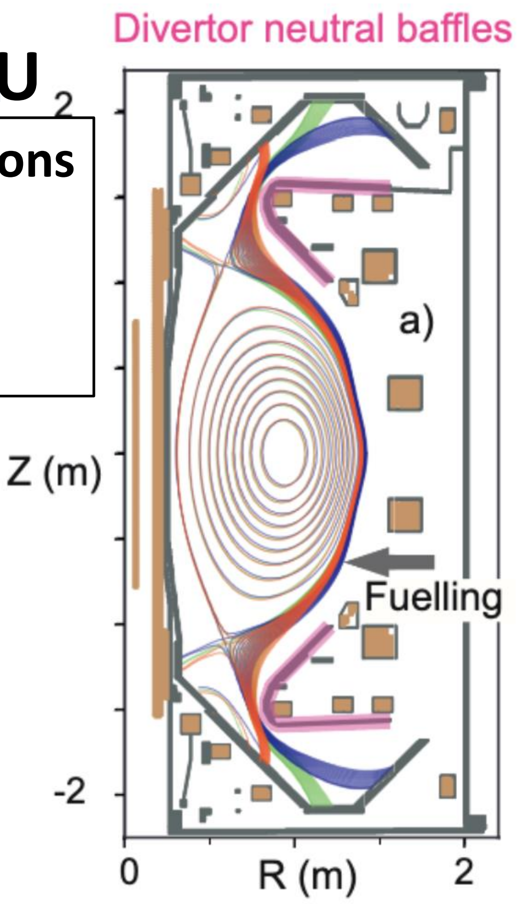
Robust strategy

- Stable XPR for 10-15s
- Soft landing for impurity legacy (slow time scale ~5s)
- Transferred to RT-06 in 2024 for high-fluence campaign with seeding

RT05-MAST-U

MAST-U - 3 divertor configurations

- Conventional Divertor (CD)
- Elongated Divertor (ED)
- Super-X Divertor (SXD)



- ADCs are investigated as potential risk mitigation strategy for power exhaust
- Strong improvements combining baffling, poloidal leg length and total flux expansion
- ADCs can provide various benefits: Easier access to detachment (37% (measured)), Lower target heat fluxes (up to x20)
- Maximum power dissipation in divertor can increase with ADCs
- Wider detachment window (up to x3.5) and more stable detachment front (up to x5 less sensitive), thus easier to control and more resilient against reattachment
- Better divertor-core decoupling

Boronisation and W limiter start up studies initiated in 2024 : a multi machine approach to ITER urgent R&D issues (RT06/RT04)

Similar restart plan for both AUG/WEST in late 2024

- **Test (briefly) start up without boronisation**
  - WEST : new bulk W inner bumper tiles / AUG : new upper divertor, first restart after long shutdown and B cleaning

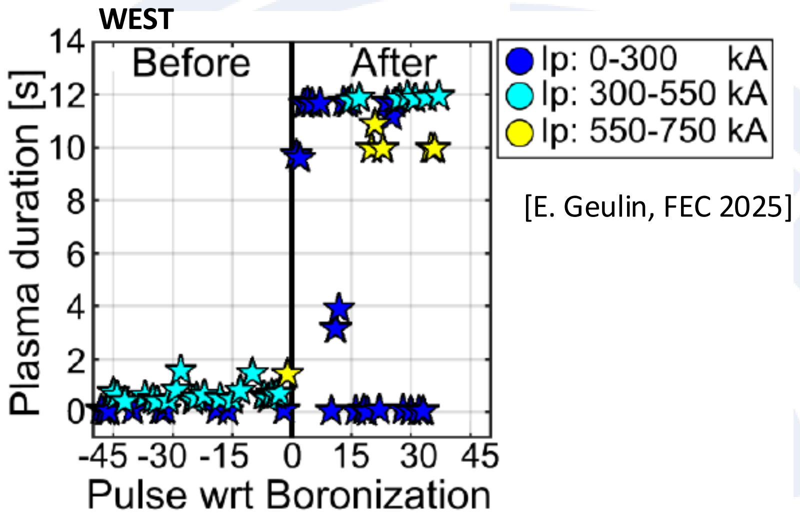
  ➔ In both machines, start up w/o boronisation very slow and challenging (RE generation in AUG) [J. Hobirk, FEC 2025]

- **Perform non toroidally uniform boronisation**
  - ITER likely to have non uniform set up for boronisation in SRO : need to assess impact
  - Most non uniform configuration selected for both machines based on modelling performed by IO (WEST : 3 of 6 diborane injection points / AUG : 2 of 4 GDB anodes)

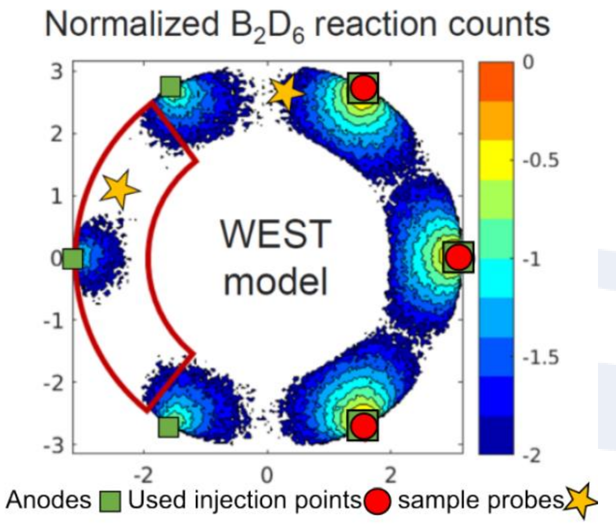
  ➔After non uniform boronisation : start up much easier in both machines (WEST operated for ~1 month w/o issue) [J. Hobirk, FEC 2025]

- **Perform uniform boronisation for comparison**

  ➔ First set of boronisation exposed samples now available from AUG and WEST (analysis starting with WP PWIE) [V. Rohde, PFMC 2025 A. Gallo PFMC 2025]

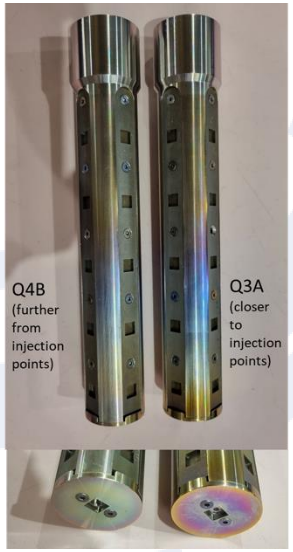


[E. Geulin, FEC 2025]



[Courtesy T. Wauters (IO), E. Geulin, FEC 2025]

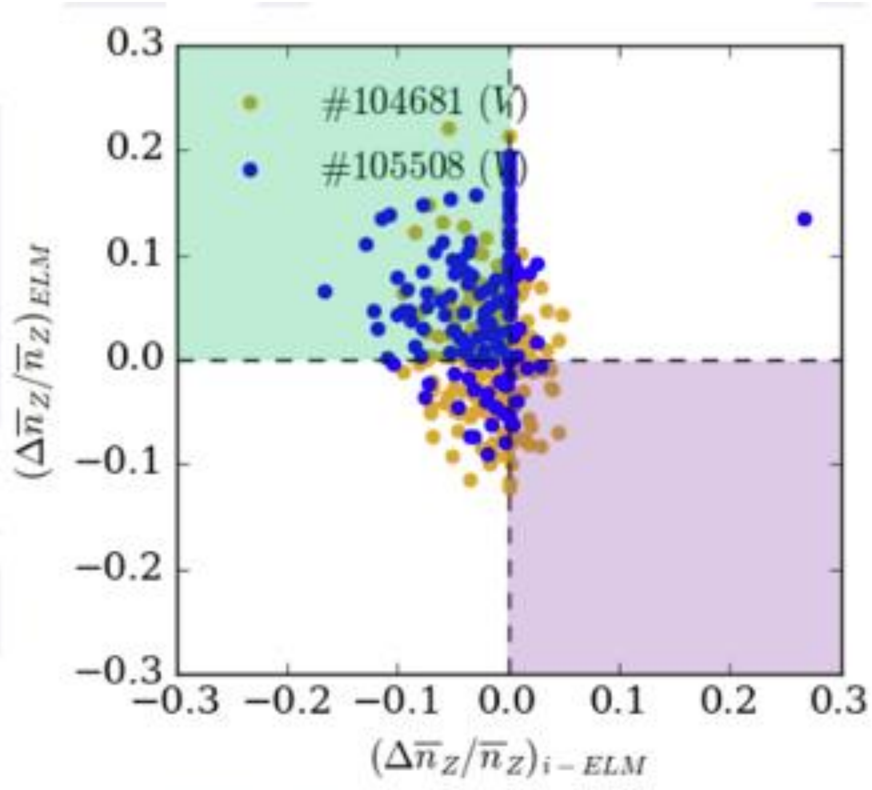
First set of samples exposed in WEST



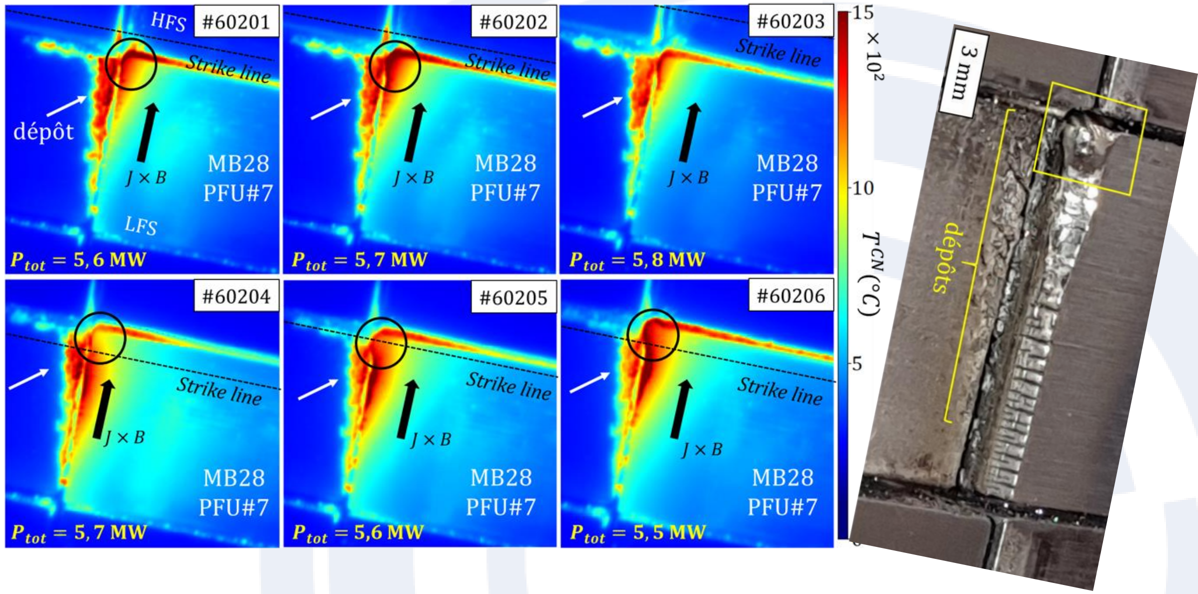
[Courtesy M. Diez]

Physics highlight from 2024 campaigns

RT01-JET: W screening investigation



- NC computation via FACIT Code (D. Fajardo PPCF 2023) suggesst that other mechanisms beyond NC screening might be relevant including: turbulent impurity transport, strong SOL W screening, interaction with other high-Z impurities not accounted for in FACIT



RT06-WEST

- Melt flow across toroidal gap experiment
- Complementary experiments in AUG (transient) and WEST (steady state loads) to validate melt layer motion code used for ITER (MEMENTO)
- Both AUG/WEST experiments confirms gap bridging

WPTE 2025 program definition

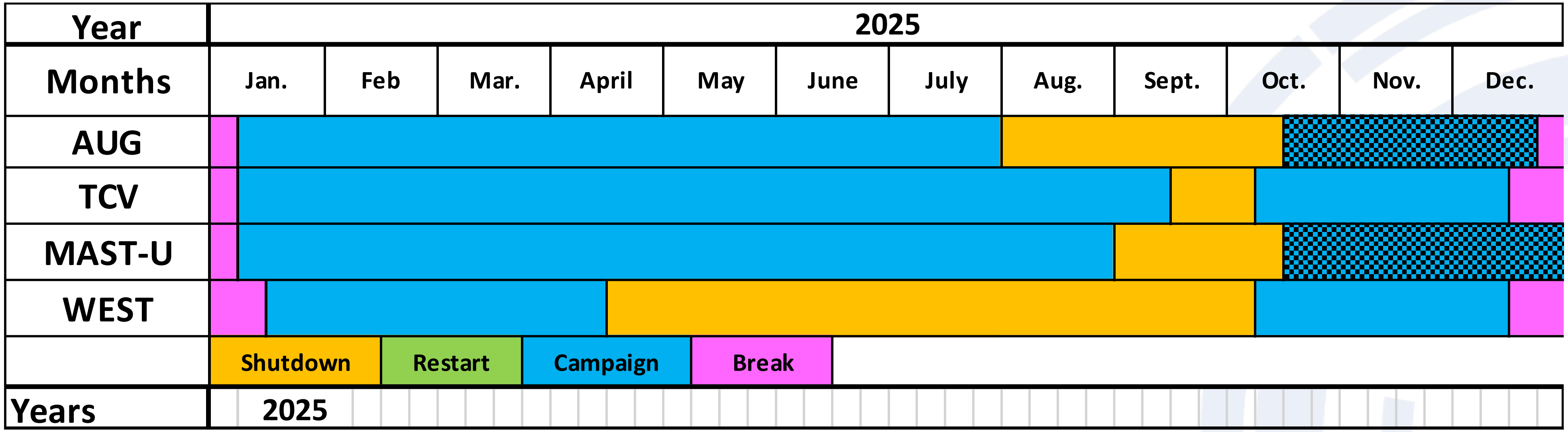
High Level Objectives

- Address urgent issues related to ITER full W using TE metallic devices (AUG, WEST + JET) : far SOL loads, W transport in pedestal, start up on W limiters, RE on W first wall, boronisation …
- Exploit the PEX upgrade of AUG towards qualifications of ADCs at high P/R
- Modelling effort for extrapolation of results from TE devices to ITER / DEMO (e.g. ADC for DEMO, impurity mix for ITER …)
- Prepare JT-60SA scientific exploitation (OP2 programme)

Organisation for 2025

- Keep the same Research Structure and RTC team
- Scientific objectives of the RT slightly amended to reflect priorities for ITER / JT-60SA (boronisation under RT06, extension of SF to multiple X point configuration under RT07, explicit links to JT-60SA in RT08/RT09 …)

Planned device availability for 2025



- Busy year for WP TE with 4 devices running in early 2025
- New features : upper divertor AUG, MAST-U cryopump, ECRH expected on WEST

	TE fraction	Shot budget
AUG	50 %	584
MAST-U	~35 %	346
TCV	40 %	1320
WEST	40 %	384

Main priorities for 2025 in present TE devices

AUG: PEX exploitation (extended H-mode operational space for ADC), SPI, W transport in H-mode and transients, High-β hybrid scenario, W PWI for ITER (boronisation, RE damage in W wall …), small-ELM

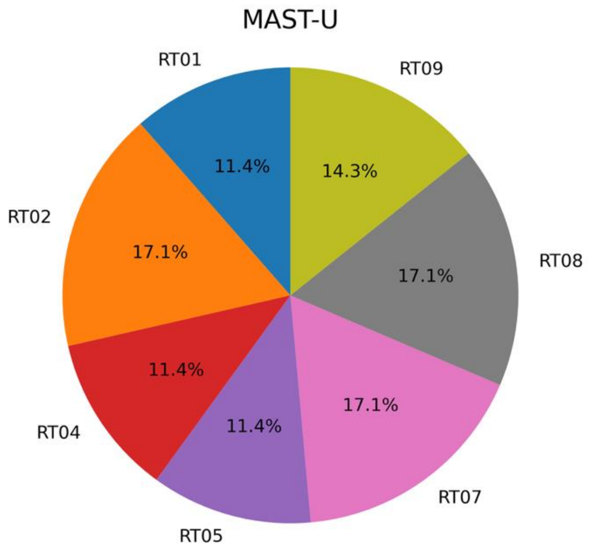
WEST: High fluence campaign, W sources and transport in long-pulse operation, W PWI for ITER (boronisation, RE damage in W wall …)

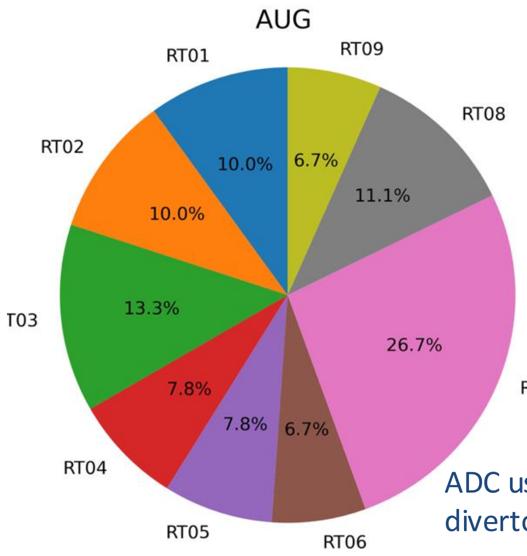
MAST-U: ADC exploration and qualification, no-ELMs, high-β, detachment studies, fast particle

TCV: ADC exploration and qualification, high-β, detachment studies, Pedestal physics (peeling/ballooning), Small-ELM/no-ELM scenarios (NT/QCE), fast particle

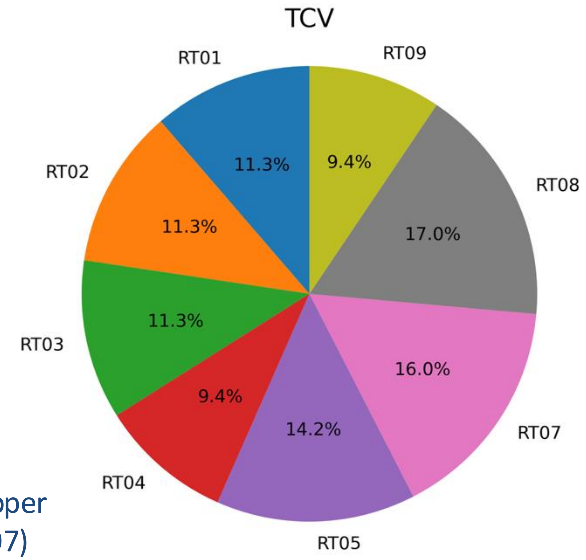
JET: Support exploitation of collected data and interpretative and predictive modelling

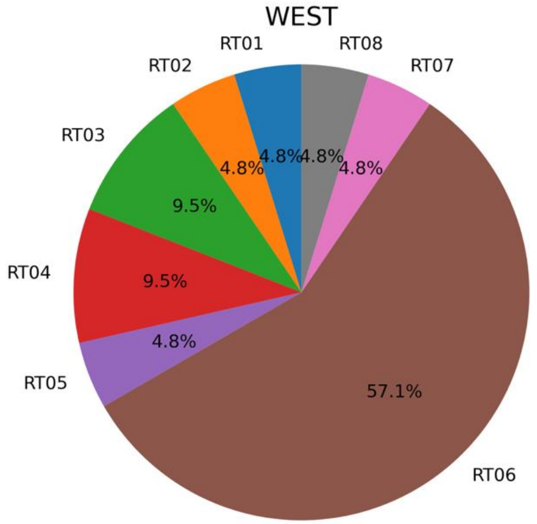
Priorities reflected in shot allocation for 2025





ADC using upper divertor (RT07)

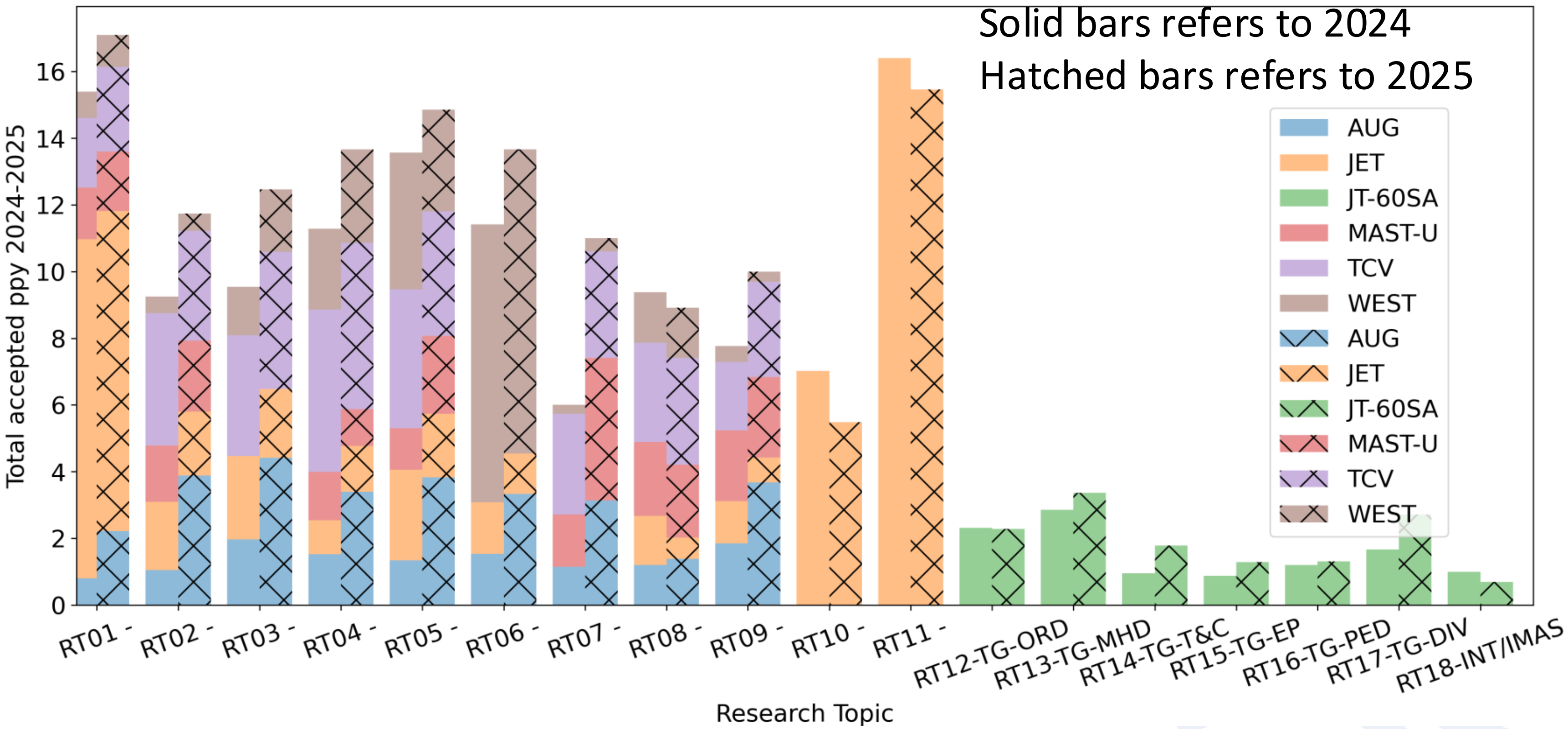




High Fluence campaign (RT06)

	AUG	MAST-U	TCV	WEST
RT01	30	24	120	15
RT02	45	48	120	15
RT03	60	0	120	30
RT04	50	32	60	15
RT05	35	32	150	15
RT06	30	0	0	180
RT07	120	48	170	15
RT08	50	48	200	15
RT09	30	40	100	0

Resource comparison 2024-2025

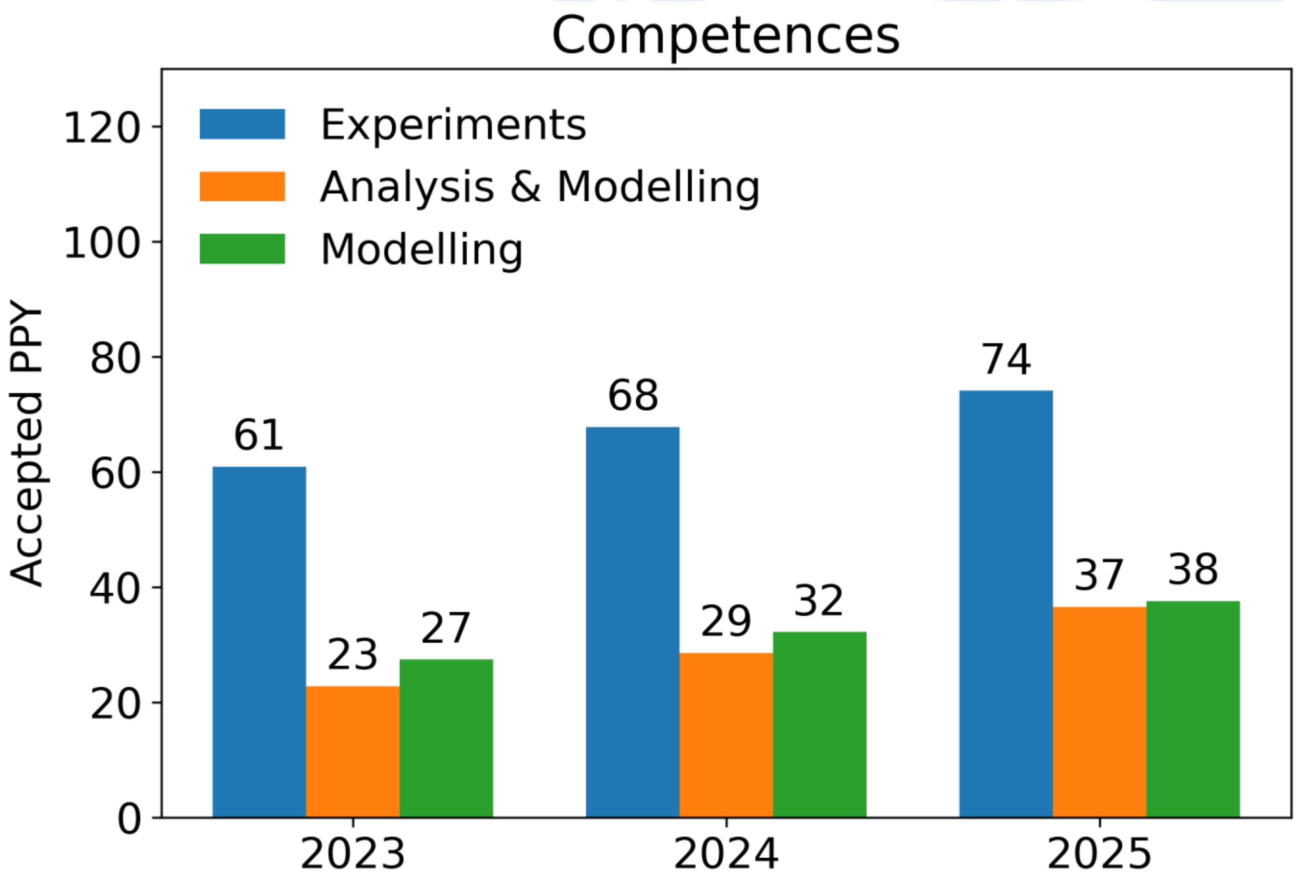


- Higher overall TE budget in 2025 (4 TE devices exploitation / preparation for JT-60SA / modelling needs)
- Higher resources for AUG scientific exploitation in 2025, as AUG now fully back on line with large operational time
- Staged increased resources for JT-60SA (OP1 analysis, transition to W, preparation for OP2)

Also note: additional mission budget planned to be transferred from campaign participation to ensure experiment participation and A&M in view of preparation of high-level conference participation (IAEA in particular)

Competences distribution

- Consistent increase of resources from 2024 to 2025 in all the Competencies
- Throughout the years WPTE has continued to increase the effort towards interpretative modelling to provide full scientific exploitation of TE experiments from experiment execution to physics understanding and future device extrapolation



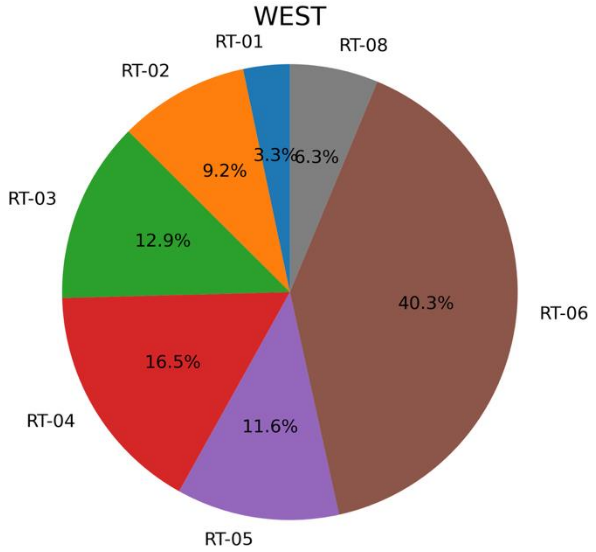
Enhancements projects launched in 2024 to be continued

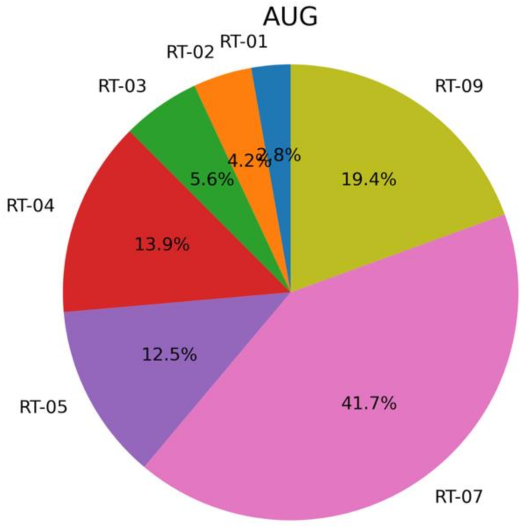
Device	Project
AUG	FIRE&GO - Fast Ion Research Enhancements and Gamma-ray Observations [at ASDEX]
	Ultra-fast-swept profile reflectometer on AUG
	Direct Digital Synthesis for the O-mode Profile Reflectometer at ASDEX Upgrade
	Real-time spectroscopy at ASDEX Upgrade
	Real-time control system for ELM buffering at ASDEX Upgrade
COMPASS-U	Tungsten impurity monitoring and control at the COMPASS-U tokamak
	Characterisation of advanced confinement modes at COMPASS-U
	PFCs and diagnostics for power exhaust studies at COMPASS-U
MAST-U	Neutron Detectors suite for 14 MeV neutron triton burnup and 2.5 MeV neutron spectroscopy measurements at MAST Upgrade
	ONCOMING-Optimized taNgentially spaCe resOlved geM ImagiNG [at MAST-U]
TCV	New 100-Hz Laser for the TCV Thomson Scattering System
	Runaway Electron Mitigation Coil for TCV
	Upgrade of the TCV LHPI antenna
	Implementation of the 4th dual-frequency gyrotron for TCV
	Collective Thomson Scattering (CTS) diagnostic for TCV
	Runaway electron mitigation and velocity analysis by magnetic-ripple manipulation [at TCV]
	Upgrade of the TCV ECRH high voltage power supply
WEST	A retarding field analyzer for ion temperature measurements in the SOL of WEST
	Boronization Probes for WEST
	LIBS4FUSION: in-vessel fuel Inventory and deposited layers composition in a full tungsten device
	Fast Ion Loss Detector in WEST
	IRBO IR Bolometry for WEST
	High DEfinition Visible Endoscope for WEST

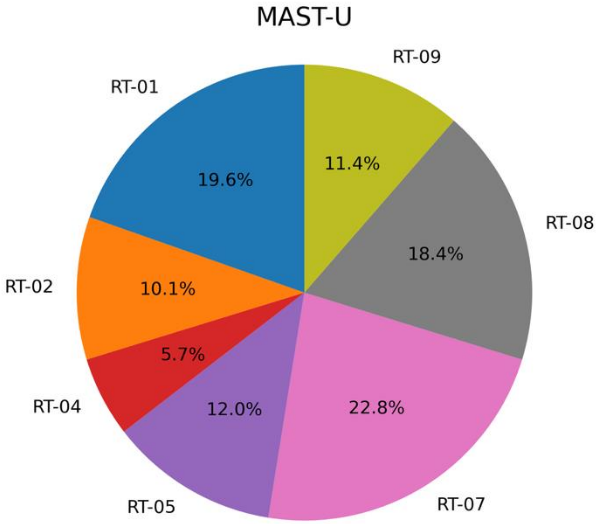
Delays announced on some projects but should still be completed in 2027 at the latest

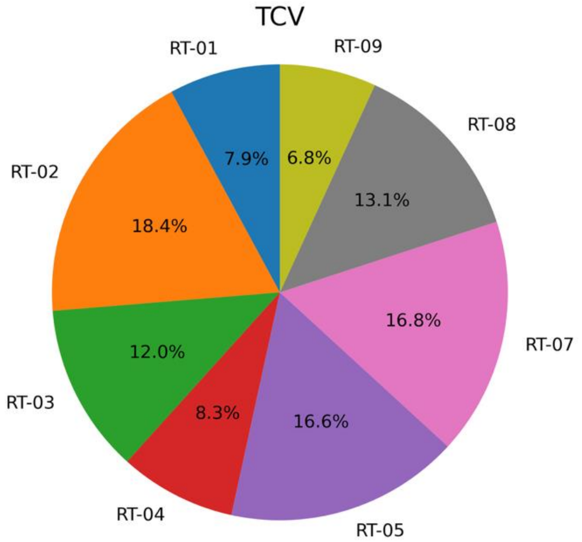
Backup

Stats of performed shots in 2024 on different devices









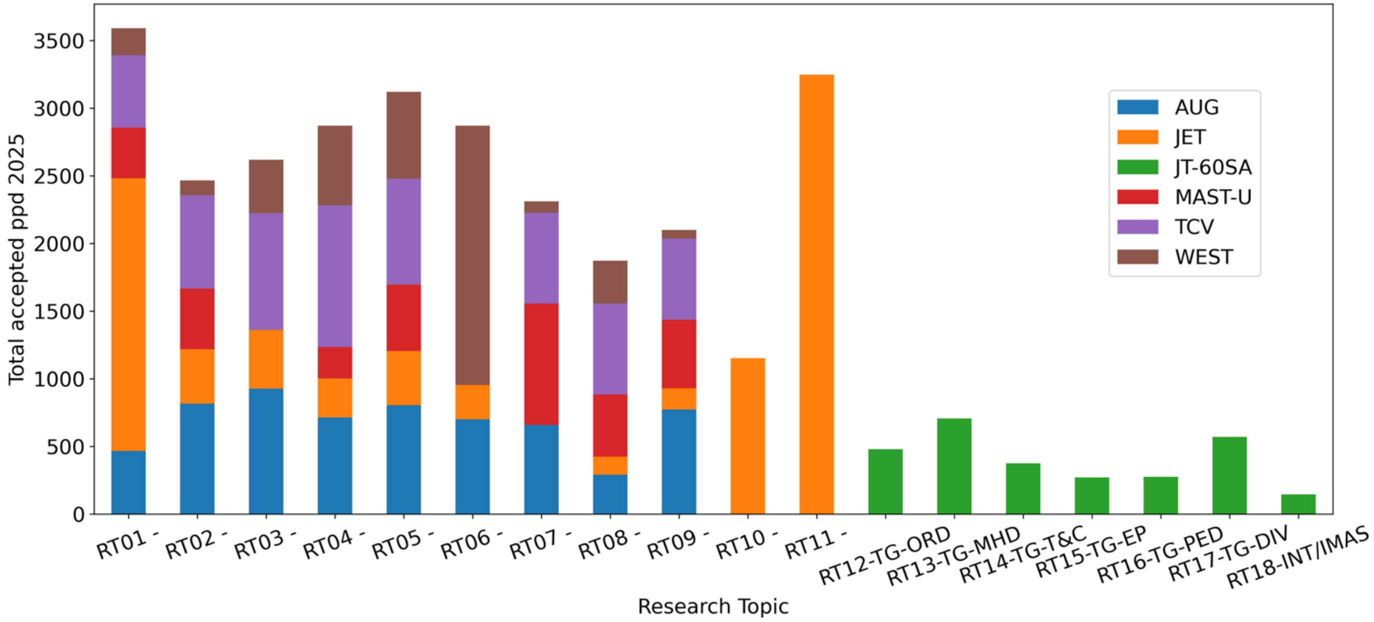
Research Topic	AUG	TCV	WEST	MAST-U
RT-01	2	105	10	31
RT-02	3	245	28	16
RT-03	4	160	39	0
RT-04	10	110	50	9
RT-05	9	221	35	19
RT-06	0	0	122	0
RT-07	30	224	0	36
RT-08	0	175	19	29
RT-09	14	91	0	18
Total	72	1331	303	158

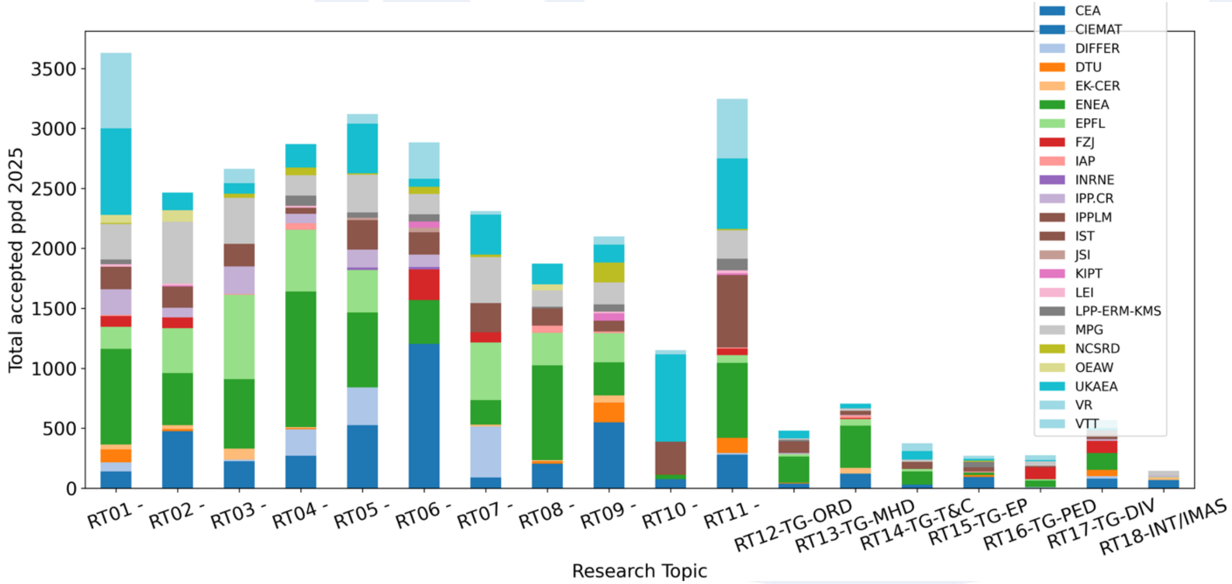
Integration of JT-60SA into WPTE started in 2024

- Jeronimo Garcia on top of his duties as ET Team Leader is also acting as Deputy Task Force Leader for WPTE, ensuring smooth integration between JT-60SA ET activities and EF
- The Different JT-60SA Topical Groups are embedded into TE program as additional JT-60SA specific Research Topics, with European Topical Group Leaders/Designated Contact Person acting as Research Topic Coordinators

	Research topic	Title	WPTE specific Names	TGL/CP
JT-60SA specific	TG-ORD	Operation Regime Development	RT12	J. Garcia
	TG- MHD	MHD Stability and Control	RT13	G. Pucella
	TG-TC	Transport and Confinement	RT14	L. Garzotti
	TG-EP	High Energy Particle Behaviour	RT15	Y. Kazakov
	TG-PED	Pedestal and Edge Physics	RT16	Y. Liang
	TG-DSP	Divertor, Scrape-Off Layer & Plasma-Material Interaction	RT17	G. Falchetto
	IMAS	Integrated Data Validation and data access with IMAS	RT18	F. Imbeaux

Resource allocation





2025 Call Cycle

	Shot requests			
RT	**AUG**	**TCV**	**MAST-U**	**WEST**
RT01	212	157	44	138
RT02	207	375	169	50
RT03	291	326	20	165
RT04	171	401	66	153
RT05	212	138	135	229
RT06	105	0	0	681
RT07	262	322	296	52
RT08	242	196	238	75
RT09	174	325	76	60
Total	**1876**	**2240**	**1044**	**1603**
Available	**584**	**1320**	**346**	**384**

Call for proposal 2025

- September 202: **Deadline 11th of October**
- Review meeting in September (23rd and 26th)

Call for participation 2025

- 28 October 2024-27 November 2024
- **GPM in person 18/19 November in Garching**

2025 Campaign

Staffing selection to be completed before Xmas 2024

Integration of JT-60SA in 2025

	Research topic	Title	IMS tag
Mission 1	RT-01	Core-Edge-SOL integrated H-mode scenario compatible with exhaust constraints in support of ITER	RT01
	RT-02	Physics understanding of alternatives to Type-I ELM regime	RT02
	RT-03	Strategies for disruption and run-away mitigation	RT03
	RT-04	Physics-based machine generic systems for an integrated control of plasma discharge	RT04
	RT-08	Physics and operational basis for high beta long pulse scenarios	RT08
	RT-09	Physics understanding of energetics particles confinement and their interplay with thermal plasma	RT09
Mission 2	RT-05	Physics of divertor detachment and its control for ITER, DEMO and HELIAS operation	RT05
	RT-06	Preparation of efficient Plasma Facing Components (PFC) operation for ITER, DEMO and HELIAS	RT06
	RT-07	Physics understanding of alternative divertor configurations as risk mitigation for DEMO	RT07
JET specific	RT-10	JET data validation	RT10
	RT-11	Analysis and modelling of DTE2 related experiments on JET	RT11
JT-60SA specific	TG-ORD	Operation Regime Development	RT12
	TG- MHD	MHD Stability and Control	RT13
	TG-TC	Transport and Confinement	RT14
	TG-EP	High Energy Particle Behaviour	RT15
	TG-PED	Pedestal and Edge Physics	RT16
	TG-DSP	Divertor, Scrape-Off Layer & Plasma-Material Interaction	RT17
	IMAS	Integrated Data Validation and data access with IMAS	RT18

- **Modification of Scientific objectives for TE EU Devices in the Call for proposals** :
  - RT08 and RT09 modification of Scientific Objectives in view of JT-60SA as a step-ladder approach towards ITER/DEMO (e.g. high β scenario with high f_g or FI population with large E/T_e or super-alfvenic population)
- **Single Call for participation launched** with proposal assessed by a combination of TE TFLs and JT-60SA TG leaders

International collaborations

- TE rationale :
  - Select topics which cannot be addressed with the capabilities of EU facilities
  - Extra attention to critical manpower resources

KSTAR : can complement EU full W devices in some specific areas

Proposed High level objectives for KSTAR exploitation with W divertor

1) Establishment of physics and operational understanding of long discharges in W environment at relevant plasma current and collisionality → complements RT01 for high Ip/ low collisionalities extended to long pulse

2) Investigation of stable operation of long pulses in detached divertor conditions → Extend RT05 detachment studies in H-mode to long pulse operation

3) Demonstration of integrated RMP control of long pulse H-mode high beta-N plasmas → extend capabilities of present EU devices to long-pulse RMP (RT02) and prepare future exploitation of JT-60SA (RT08)

4) Exploration of disruption & runaway electron mitigation and avoidance in long pulses → extend present SPI investigation to double SPI (RT03)

5) Implementation of wall monitoring and Plasma Facing Components characterization

EU-US collaboration on small-ELMs

- Initiative from DoE and EUROfusion (EU-US Energy Council, March 2023)
- Multi-year plan for EUROfusion and US DOE collaborative activities:
  - New experiments
  - Data analysis from tokamaks in EU and US
  - Theory & Modelling of plasma regimes without ELMs.
- Timeline
  - Currently structured as 2(yr)+2(yr) (starting this year 2024)
  - Project Agreement (PA) to be signed off by DOE and EUROfusion
  - Draft PA agreed by DoE —> Final version expected by mid-November
- 6 subgroups lead by 2 experts
  - QH-mode: Darin Ernst, USA & **Eleonora Viezzer**, EU
  - I-mode: Amanda Hubbard, USA & **Davide Silvagni**, EU
  - EDA/QCE H-mode: Nils Leuthold, USA & **Michael Faitsch**, EU
  - Negative Triangularity: Oak Nelson, USA & **Olivier Sauter**, EU
  - XPR with no-ELM: F. Scotti, USA & **M. Bernert, EU**
  - Theory and Simulation: Fatima Ebrahimi, USA & **Andres Cathey**, EU
  - Overall coordination: Xi Chen, USA & **Benoit Labit**, EU

Provisional budget for 2025 : main objectives

Initial provisional budget for 2025 build in 2023, now revised in the light of 2024

Staffing

- Increase of staffing for campaign participation on TE devices : intensive exploitation of AUG
- Pursue the effort on modelling (PCR already granted in 2024 for 2025)
- Maintain the effort on JET data validation + analysis and interpretative modelling for completing publications foreseen in major conferences in 2025 (IAEA in particular)
- Maintain effort on JT-60SA at the same level as in 2024 for IC analysis (to be further discussed with JG)

Missions

- Campaign participation consistent with staffing
- Keep on site meetings, as very beneficial for accelerating data analysis / modelling
- Keep INCO at same level as in 2024 as EUROfusion strenghtening international collaboration