PSD Project Board # 05

WPTE

N. Vianello and E. Tsitrone for TE TFL

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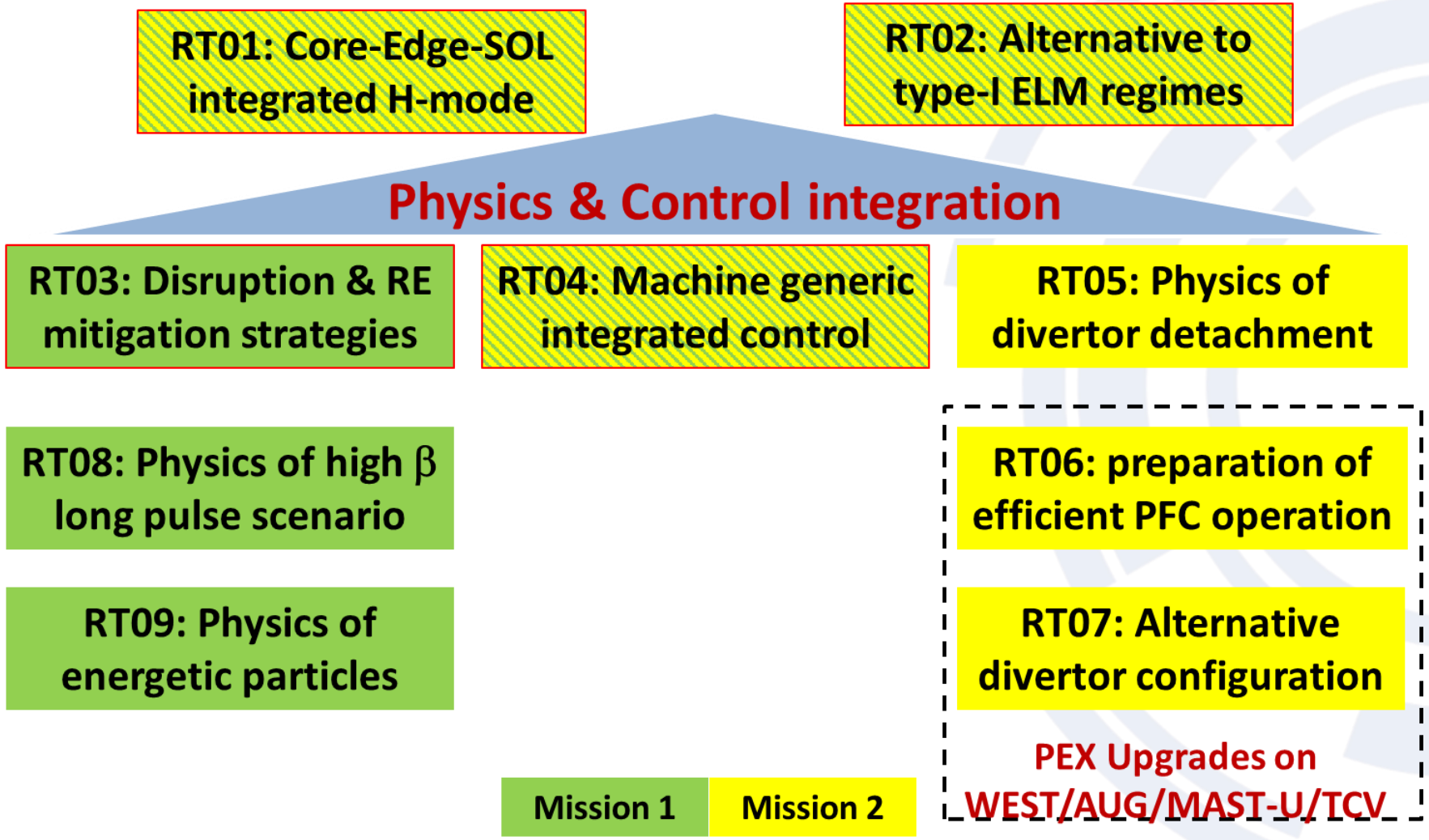
2024 WPTE programme at a glance

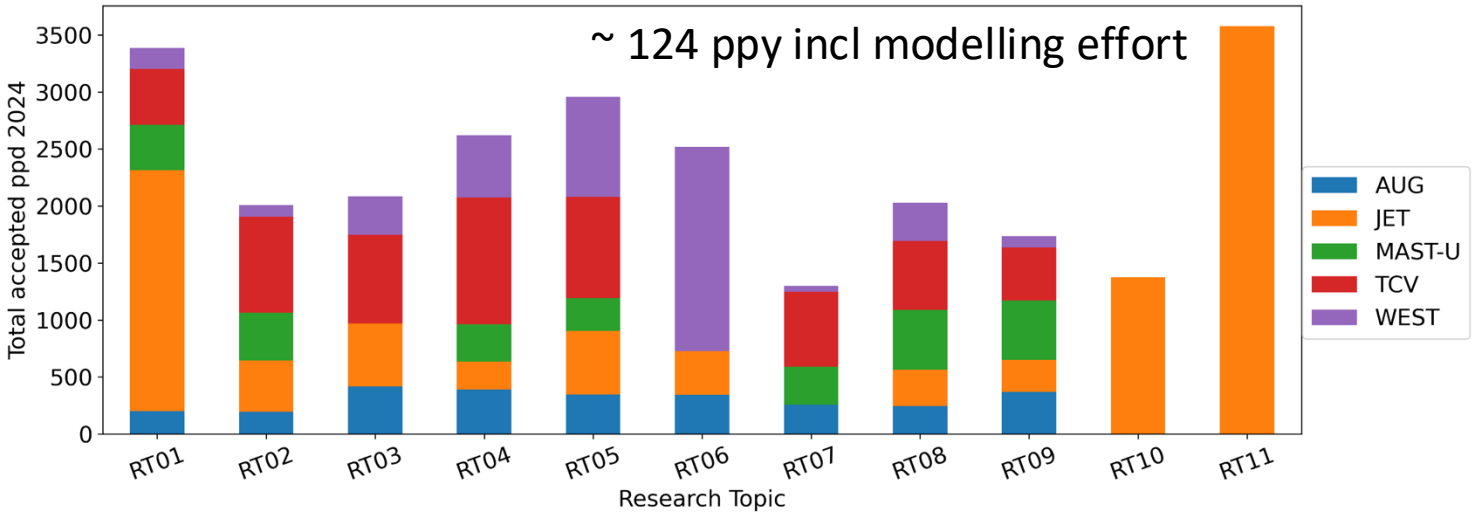
	Jan	Feb	Mar	April	May	June	July	Aug	Sept	Oct	Nov	Dec
AUG												
TCV		NINO							SILO		LILO	
MAST-U										MU04		
WEST		C9								C10		

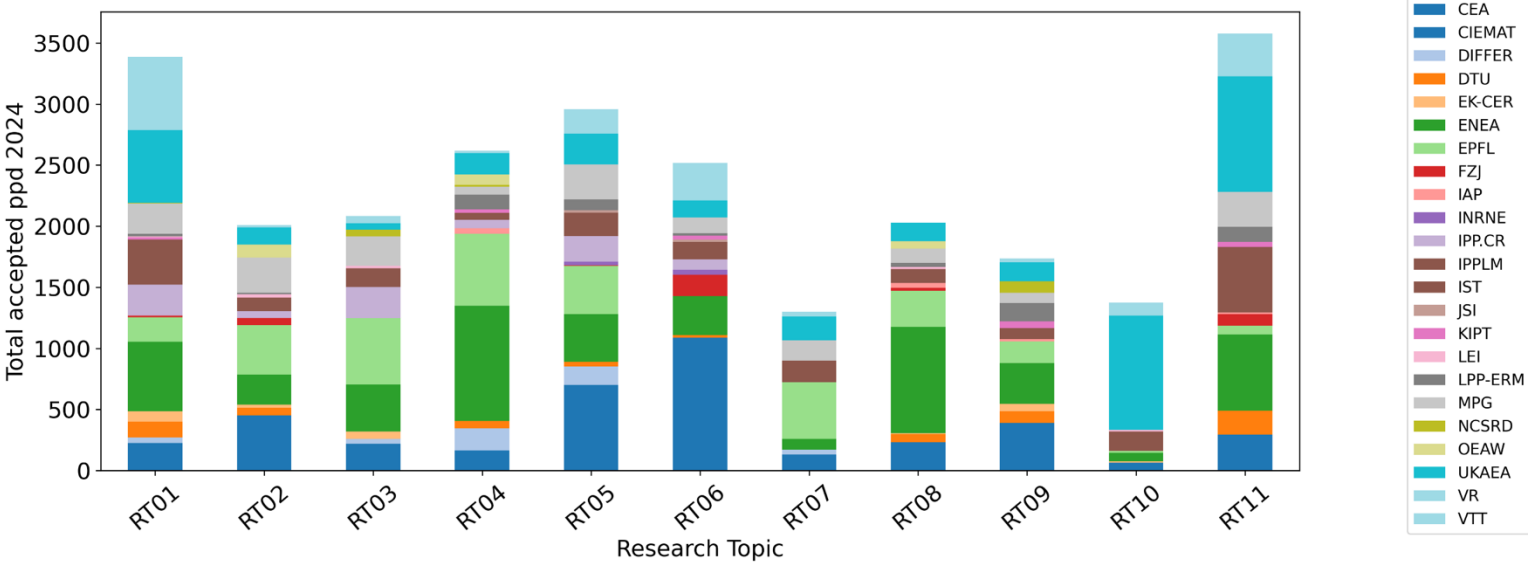
- Operation mainly on TCV and WEST with MAST-U and AUG to resume experiments from late Oct till end of the year
- **ITER new baseline R&D requests** already incorporated into the programme in 2024 (boronisation, plasma start up on full W …)
- **On site meetings** re-initiated (JET analysis weeks, Tervaniemi, TE+PWIE, GPM …) : mission budget fully used (as planned)

2024 Research Structure in continuity

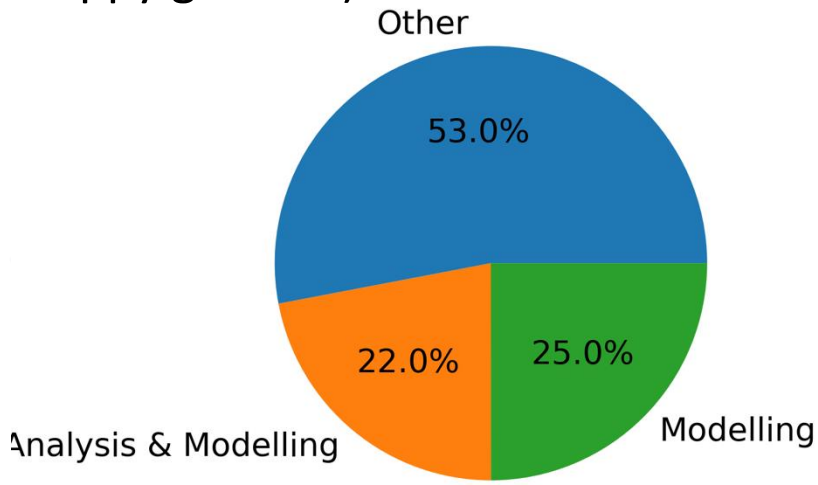


WPTE resource distribution in 2024



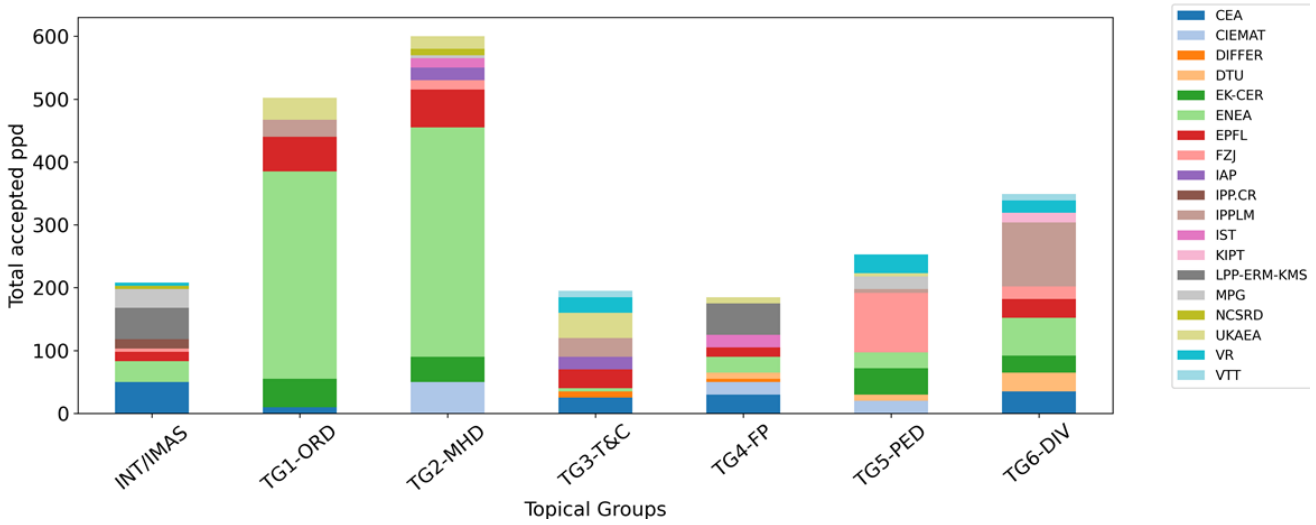


- WPTE : cross-device program with strong contribution by all the EUROfusion beneficiaries
- JET data validation/modelling/scientific exploitation still essential in WPTE strategy (significant backlog for data validation)
- Additional effort on modelling (interpretative + extrapolation to ITER/DEMO) started (PCR : additional > 15 ppy granted)



Integration of JT-60SA into WPTE started in 2024

- JT-60SA integration started with WPTE call for A&M activities

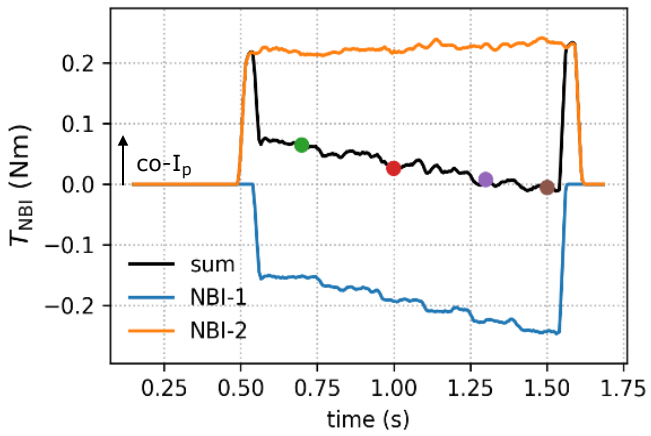


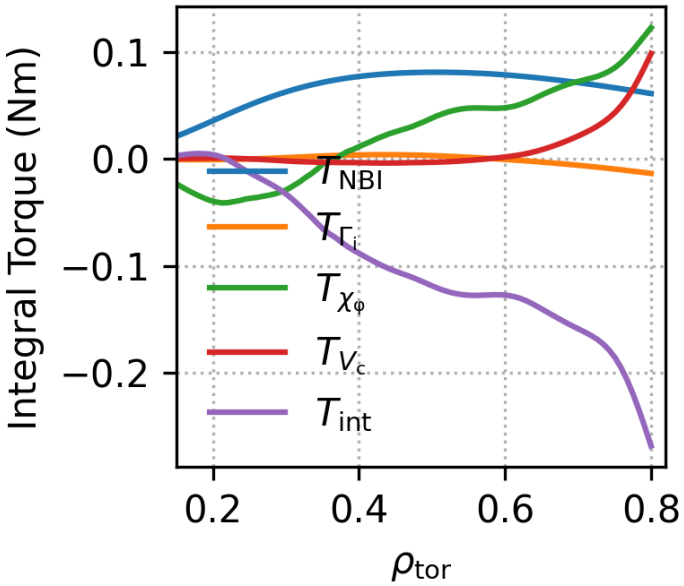
- 10.5 ppy selected for analyzing IC1, as budgeted under SA (<10% of the overall TE-2 campaign participation)

JT-60SA Topical Groups	Title	TG leader
TG1 - ORD	Operation Regime Development	Takuma Wakatsuki (QST)
TG2- MHD	MHD Stability and Control	Gianluca Pucella (ENEA)
TG3 – TC	Transport and Confinement	Luca Garzotti (UKAEA)
TG4- EP	High Energy Particle Behaviour	Yevgen Kazakov (LPP-ERM/KMS)
TG5-PED	Pedestal and Edge Physics	Nobuyuki Aiba (QST,)
TG6- DSP	Divertor, Scrape Off Layer and Plasma-Material Interaction	Tomohide Nakano (QST)
IMAS	Integrated data validation and data access with IMAS	

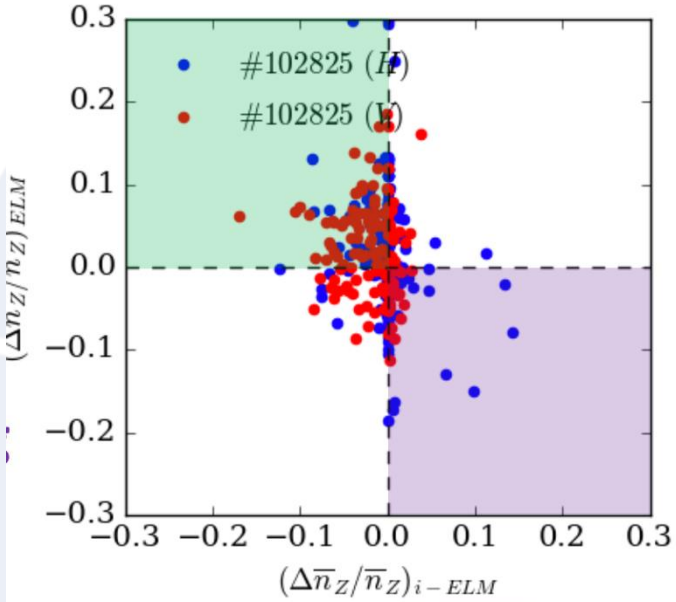
Physics highlight from 2024 Campaigns

RT01-TCV





RT01-JET



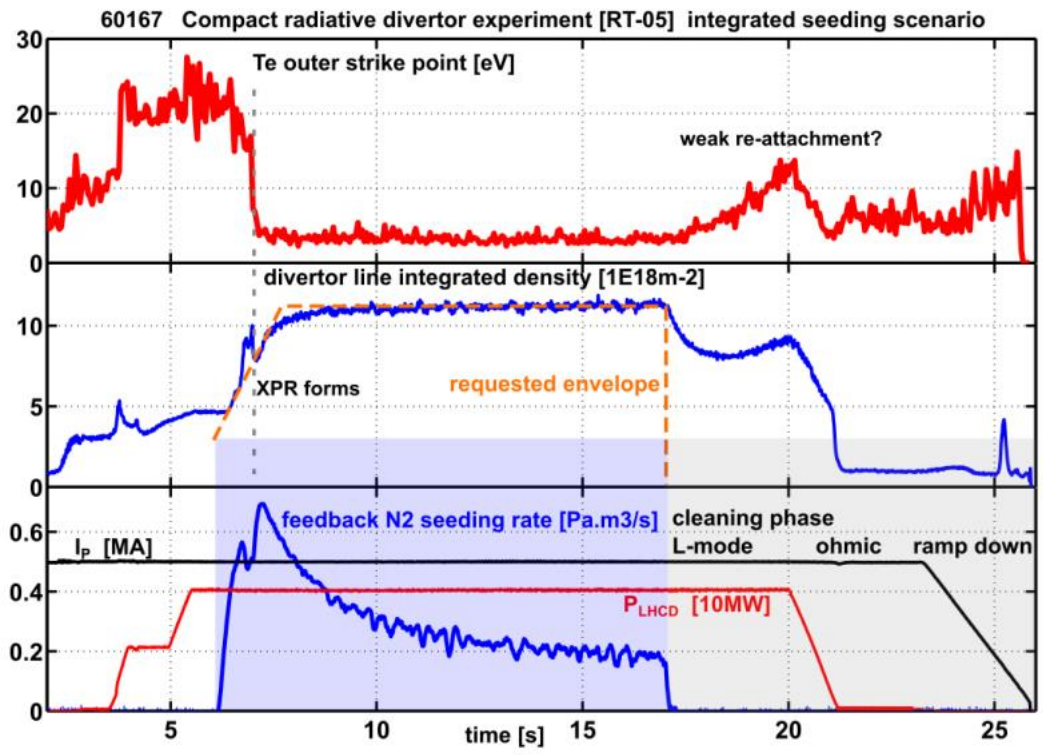
Results achieved on TCV L-mode:

- Zero velocity reached outside the sawtooth inversion radius with a combination of co/cntr NBI
- The **FIRST WPTE** tokamak to achieve “a direct measurement” of intrinsic torque
- Intrinsic torque profiles obtained for NBI only and NBI+ECH plasmas at several densities
- Extension to H-mode in progress

- W screening observation confirmed and enhanced in lower current hybrid scenario
- NC calculation suggest that other mechanism might play a role as : turbulent impurity transport or SOL W screening

Physics highlight from 2024 campaigns

RT05-WEST

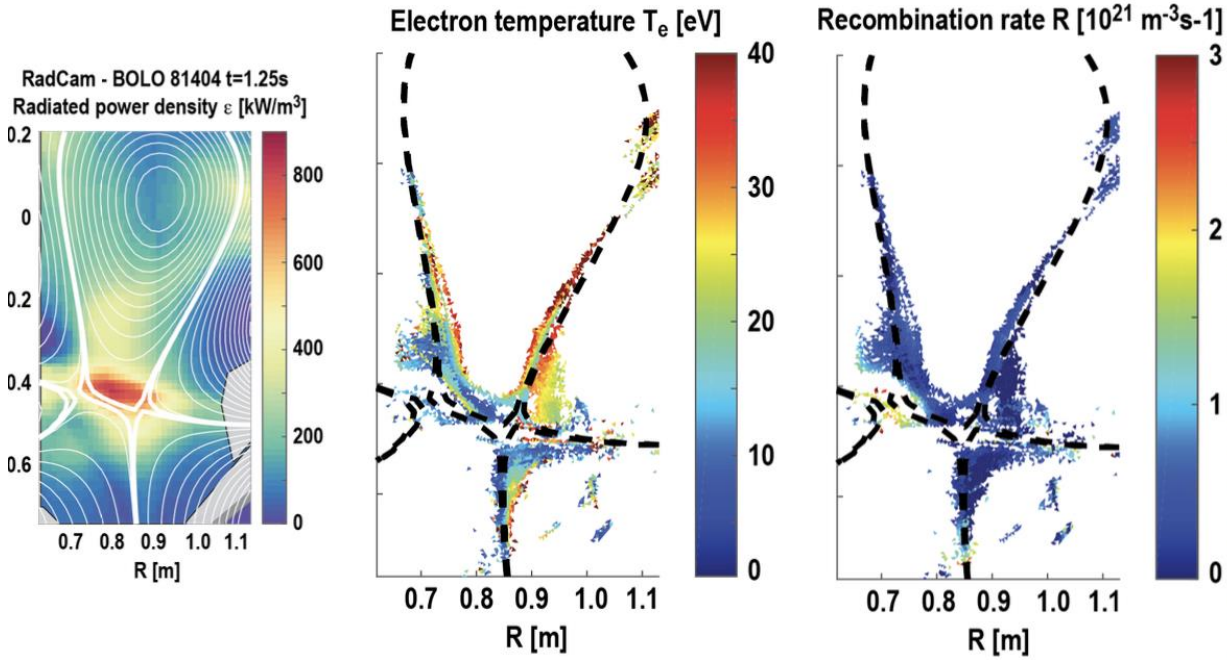


Robust strategy

- 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

RT07-TCV

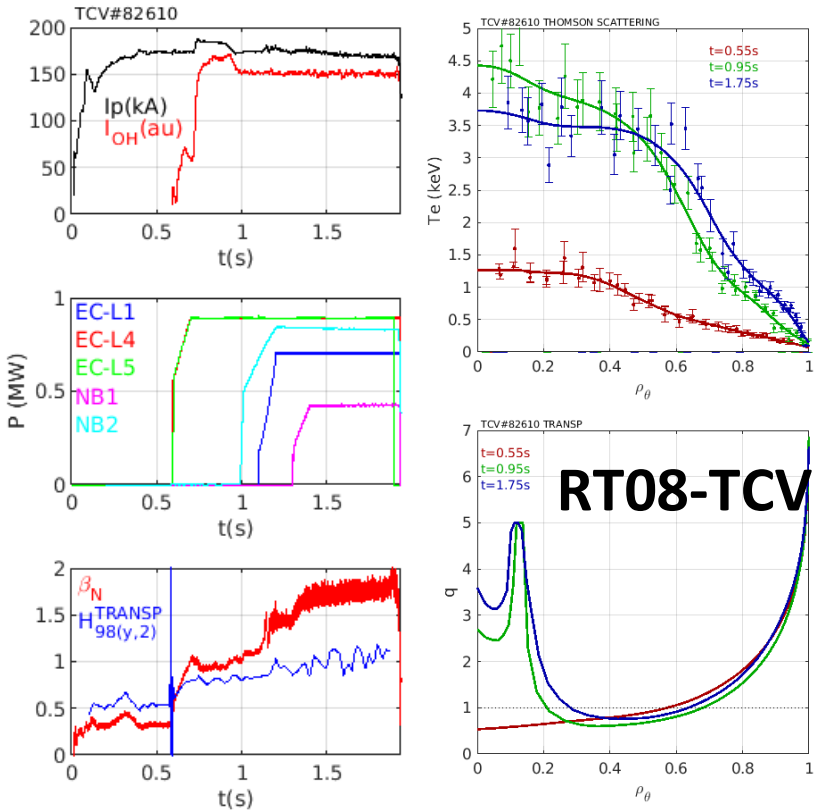
MANTIS indicates low temperatures in XPR and signs of recombination at inner X-point (yes below ionisation rate)



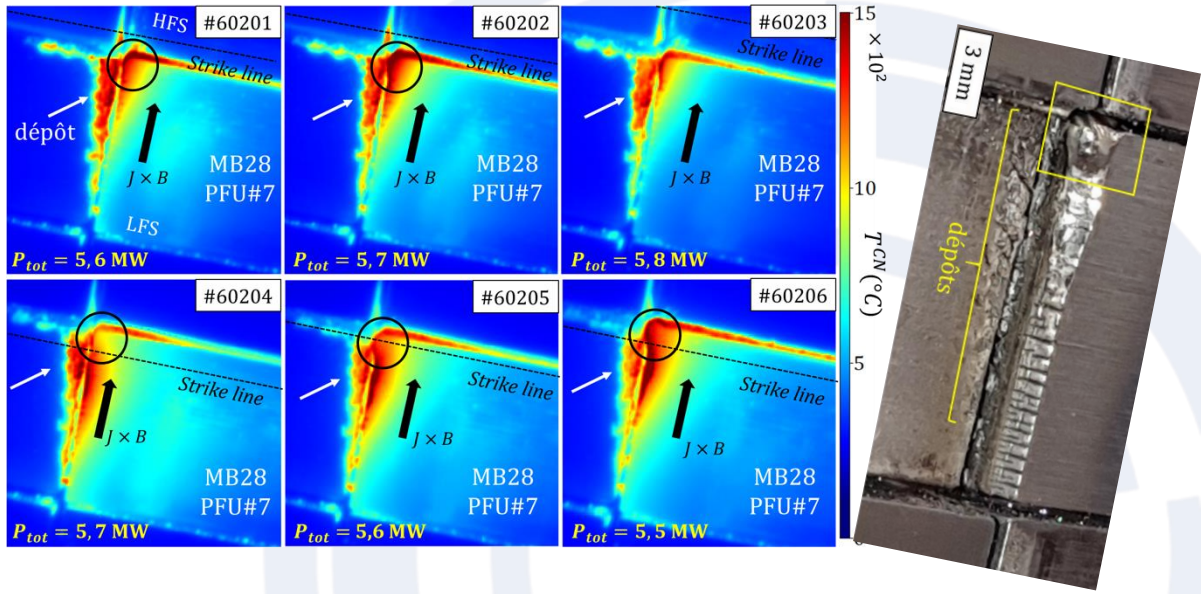
[Reimerdes and Perek]

2D Te map from MANTIS diagnostic with significant signature of recombination at inner X-point

Physics highlight from 2024 campaigns



- Steady-state fully non-inductive Double Transport Barrier (DTB) scenario
- Broad Internal TB (ρ_θ~0.7) in both T_e and n_e profiles
- $<\beta_N>$~1.8 and $<H_{98(y,2)}>$~1 for 0.5s (5X current diffusion time)



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

Evolution of SSRL under discussion

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

RT	Title	D1	D2	D3	D4	D5	D6	D7
RT-01	Core-Edge-SOL integrated H-mode scenario compatible with exhaust constraints in support of ITER	X		X		X	X	X
RT-02	Physics understanding of alternatives to Type-I ELM regime			X			X	
RT-03	Strategies for disruption and run-away mitigation		X				X	
RT-04	Physics-based machine generic systems for an integrated control of plasma discharge	X		X		X		
RT-05	Physics of divertor detachment and its control for ITER, DEMO and HELIAS operation		X				X	
RT-06	Preparation of efficient Plasma Facing Components (PFC) operation for ITER, DEMO and HELIAS		X		X	X		
RT-07	Physics understanding of alternative divertor configurations as risk mitigation for DEMO	X			X			
RT-08	Physics and operational basis for high beta long pulse scenarios							
RT-09	Physics understanding of energetics particles confinement and their interplay with thermal plasma					X		

- "X" : scientific objective improvements in 2023 compared to 2022

Expected evolution in 2024: further improvements to be completed once L3 reports are available

Status of grant deliverables

"Title" in Sygma	Title in CWP	Initial due Date	Expected deliverable date	Status	Comments/Reason for delay
TE.D.08	Balance between gross and net erosion of W under different operational conditions in full-metallic toroidal devices	Dec 2023	Dec 2024	To be completed this year	Good data set in L mode and H mode. Modelling for H mode + W prompt redep still ongoing
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	Proposal to defer to 2025	Proper GK analysis concerning impurity effects on pedestal not yet available
TE.D.14	The radiation asymmetry during disruption mitigation and SPI disruption dynamics using improved power balance, radiation diagnostics capability and fast cameras characterized and documented.	Dec 2024	Dec 2024	To be completed this year	JET and AUG data published. JOREK modelling
TE.D.12	The physics basis for the decision for an alternative divertor configuration for DEMO.	Dec. 2024	Dec 2025	Delayed	Upper divertor of ASDEX Upgrade delayed and considered important
TE.D.13	Recommendation on the seeding impurity mix in view of a future reactor.	Dec. 2024	Dec 2025	Delayed	Data exists – but analysis progress by end of year unclear

Enhancements projects launched on all TE devices

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

TE management and leadership modification

- Following the restructuring of the PMU and the newly established PSD department, modification of the management of TE

Role	Name
Task Force Leader	Emmanuelle Tsitrone
Task Force Leader	Nicola Vianello
Deputy Task Force Leader	Matteo Baruzzo
Deputy Task Force Leader	Antti Hakola
Deputy Task Force Leader	David Keeling
Deputy Task Force Leader	Jeronimo Garcia
Deputy Task Force Leader	Valentin Igochine
Deputy Task Force Leader	Benoit Labit

WPTE 2025 program definition

High Level Objectives

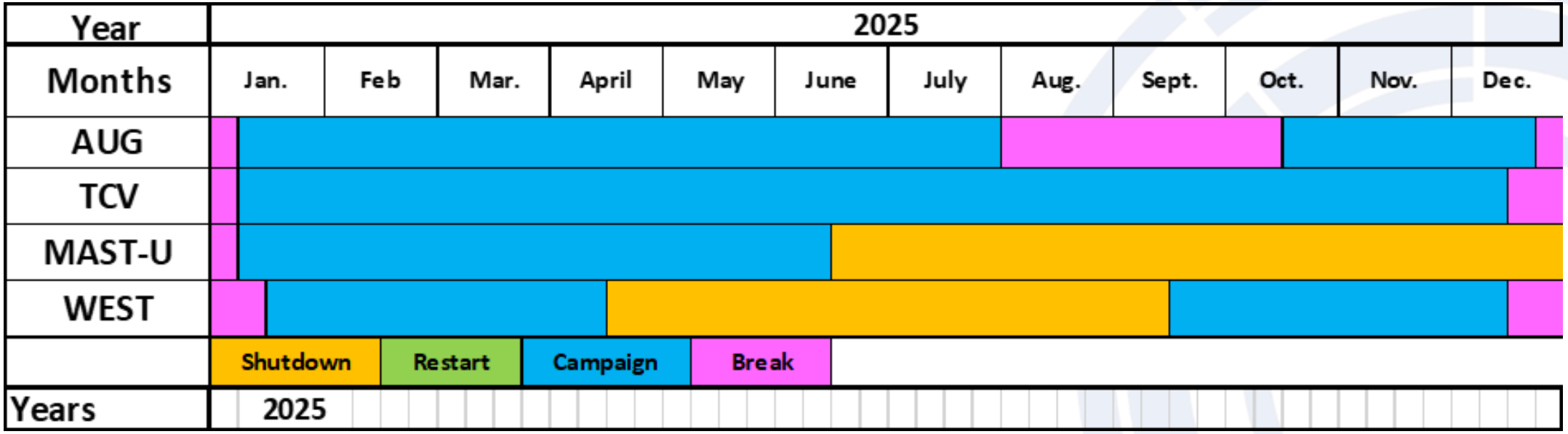
- Address urgent issues related to ITER full W using TE metallic devices (AUG, WEST + JET) : far SOL loads, W transport in pedestal, start up on W limiters, RE on W first wall, boronisation …
- Exploit the PEX upgrade of AUG towards qualifications of ADCs at high P/R
- Modelling effort for extrapolation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

2025 Research Topic Structure

Structure of the programme

- Same structure kept with 9 Research Topics (RT) + 2 Research Topics for JET (data validation / data analysis from past campaigns)
- Scientific objectives of the RT slightly amended to reflect priorities (boronisation under RT06, extension of SF to multiple X point configuration under RT07, explicit links to JT-60SA in RT08/RT09 …)
- Coordination : same team of Research Topics Coordinators (RTC)

Planned device availability for 2025



- Busy year for WP TE with 4 devices running in early 2025
- AUG catching up, TCV running ~continuously (short shutdowns for changing baffle configurations)
- New features : upper divertor AUG, ECRH on WEST, MAST-U cryopump

	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: Full exploitation of collected data and interpretative and predictive modelling

Priorities reflected in the tentative shot allocation for 2025 (to be revised after General Planning Meeting)

AUG: PEX exploitation, SPI

	AUG	MAST-U	TCV	WEST	Sum
RT01	30	24	120	15	189
RT02	45	48	120	15	228
RT03	60	0	120	30	210
RT04	50	32	60	15	157
RT05	35	32	150	15	232
RT06	30	0	0	180	210
RT07	120	48	170	15	353
RT08	50	48	200	15	313
RT09	30	40	100	0	170
Cont	134	74	280	84	572
Sum	**584**	**346**	**1320**	**384**	**2634**

WEST: High fluence campaign

MAST-U: ADC, high-β

TCV: ADC, high-β

- More emphasis on RT08/RT09 than in previous years

2025 Call Cycle

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

	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

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