09th- 10th November 2026

RT-03 “Strategies for disruption and run-away mitigation” Discussion about proposals and allocated priorities

V. Igochine

Ref. TFLs: V.Igochine and A. Hakola

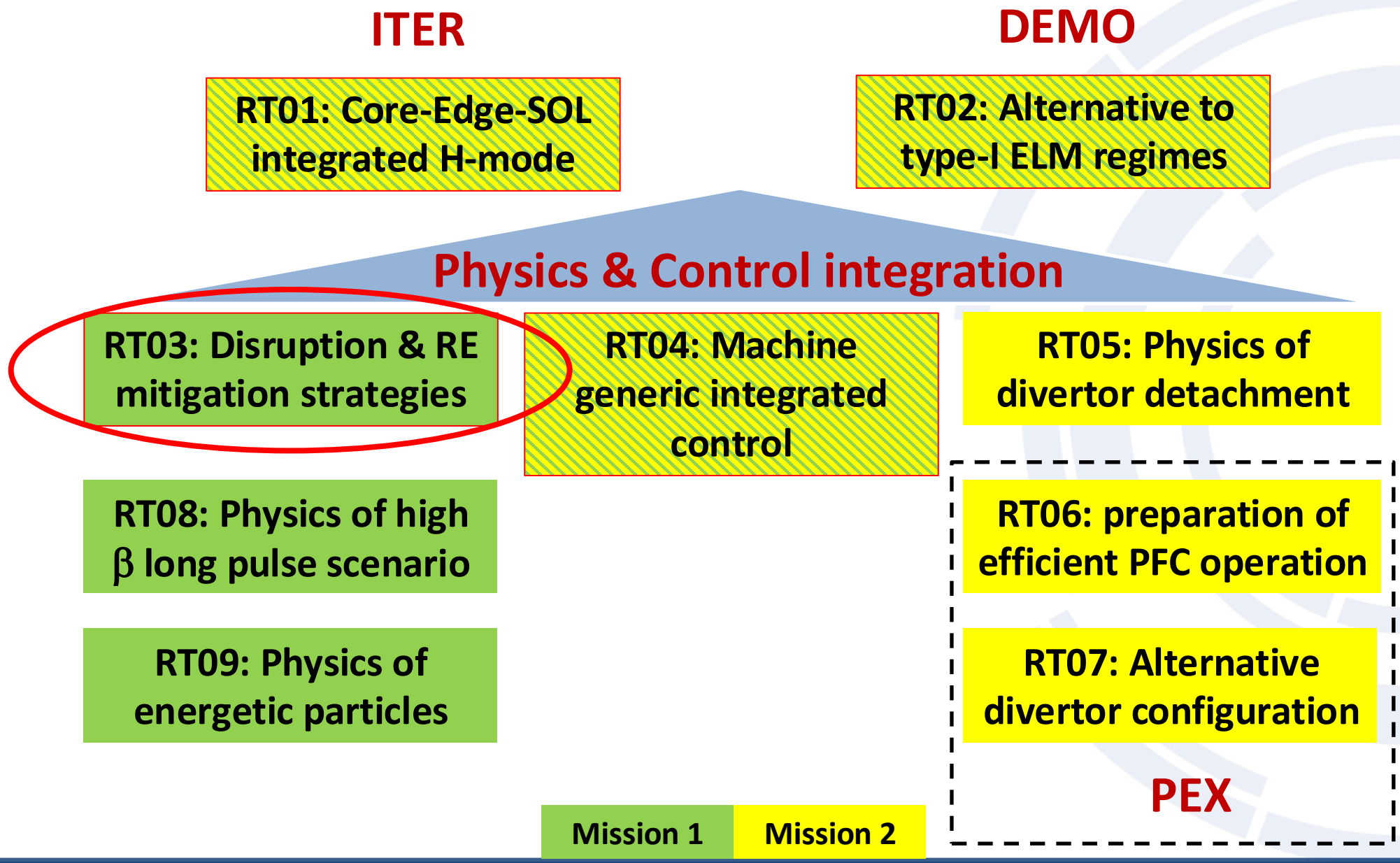
On behalf of WPTE TFLs
E. Tsitrone, N. Vianello, Vito Konrad Zotta, Y.Kazakov, V. Igochine, D. Keeling, A. Hakola, B. Labit

Research Topic Coordinators

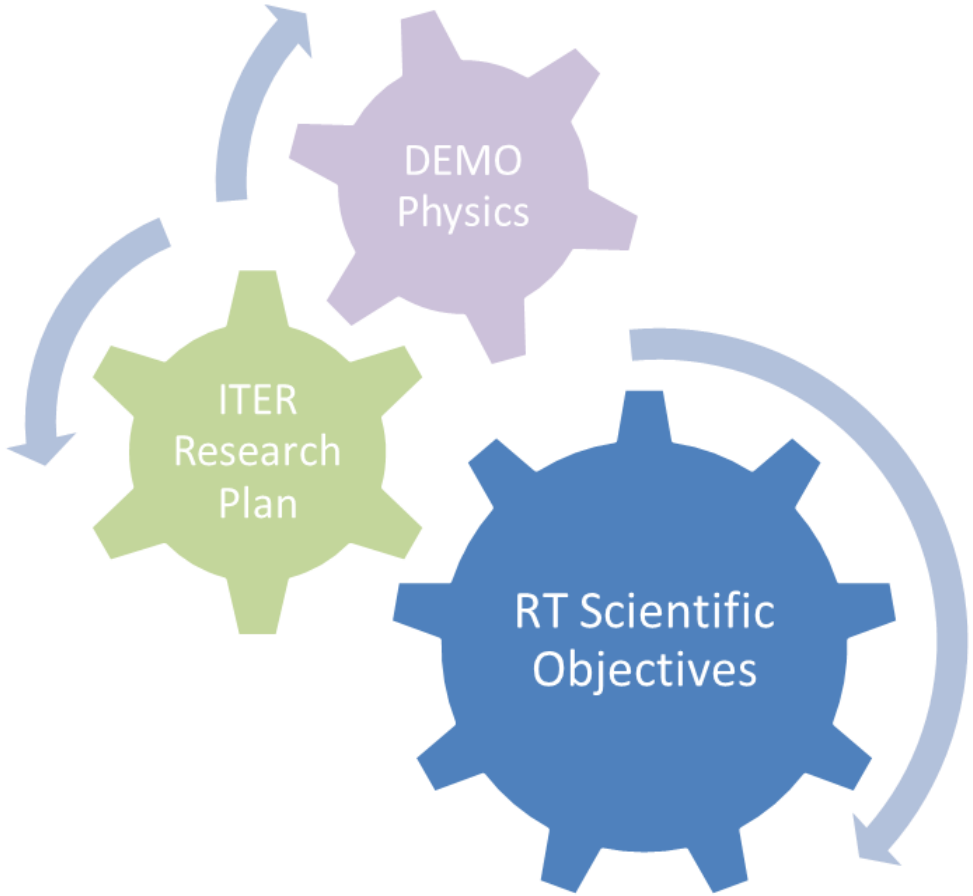
O. Ficker, S. Jachmich, C. Reux, U.Sheikh

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Introduction



Prioritization scheme



Evaluated according to the criteria:

Meeting the set Scientific Objectives

Size and feasibility

Team effort

All these aspects were considered by the TFLs when setting the priorities – according to the following scheme

P1-2026-DEV: experimental priority for 2026: machine time granted but pulse budget might need reduction

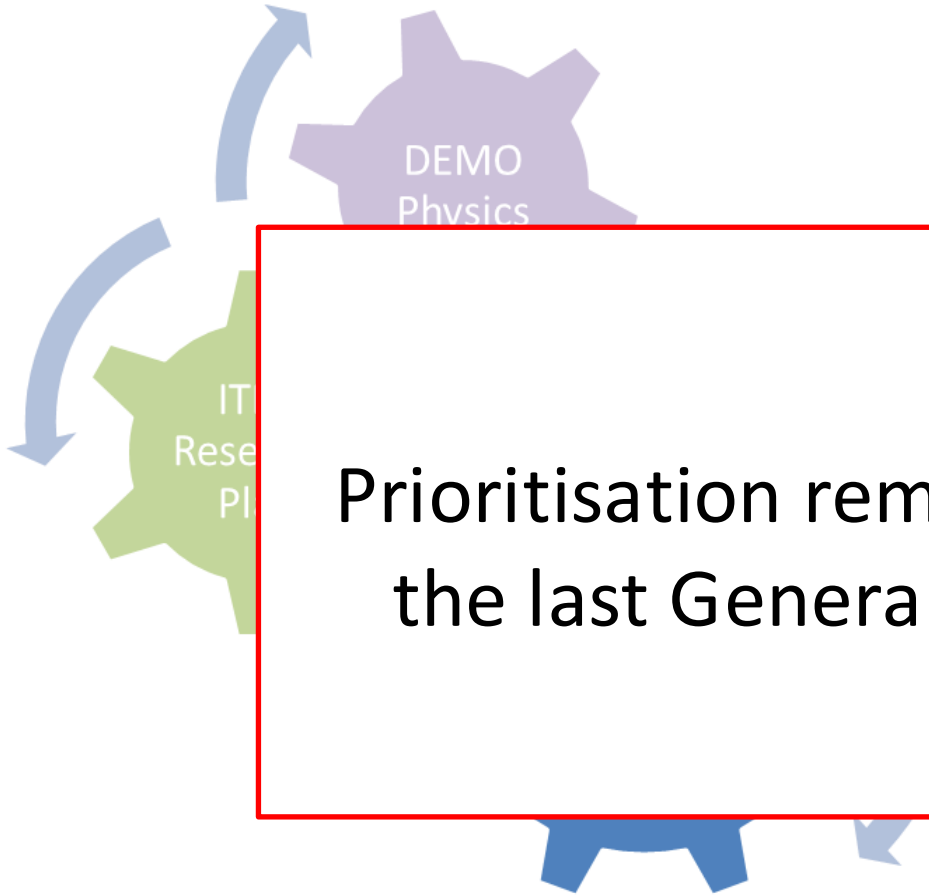
P1-2027-DEV: experimental priority for 2027: machine time granted but pulse budget might need reduction

P2-DEV: will be done if time allows after *all* P1 proposals are completed

P3: low priority programme/out of scope

PB: piggy-back experiment/pure analysis proposal

Prioritization scheme



All these aspects were considered by the TFLs when setting the priorities – according to the following scheme

Prioritisation remains as it was decided at the last General Planning meeting

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Evaluated according to the criteria:

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Scientific Objectives was redefined during last GPM

Until the end of 2025

Research Topic	Scientific objectives	Status as reported end of 2024	SSRL proposed by RTCs based on 2025 activities
RT03: Strategies for disruptions and runaway mitigations	**D1:** Optimize disruption mitigations by single and multiple shattered pellet injection (SPI) at high plasma current and energy content in an all-metal environment to validate the ITER disruption mitigation strategy	Judgemental	Judgemental
	D2: Quantify the required neon quantity for SPI into dilution cooled plasmas for sufficient thermal and current quench mitigation in ITER and the synchronisation requirements for dual deuterium/neon SPI in ITER	Judgemental	Mature – needs under pinning
	D3: Characterize/optimize the RE impact mitigation schemes and their interactions with the RE companion plasma with different hydrogen/deuterium injection techniques	Mature – needs underpinning	Mature – needs underpinning
	D4: Determine the physics mechanisms generating run-away electrons in the current quench and in the plasma start-up phase	Judgemental	Judgemental
	D5: Interpretative modelling of disruption mitigation dynamics (TSVV-8, TSVV-9) and prediction for ITER	Judgemental	Judgemental
	D6: Quantify the radiation asymmetry during disruption mitigation with SPI	Mature – needs underpinning	Mature – needs underpinning
	D7: Validate the modelling of image currents in conducting structures during disruption with halo current measurements	Emerging	Exploratory

2026 - 2027

Scientific Objectives
D8 Develop an understanding of pellet assimilation for plasma densification in shattered pellet injection (SPI) experiments to avoid runaway electron (RE) generation
D9 Develop an understanding of SPI dynamics in off-normal plasmas, such as close to density limit and/or during impurity accumulation
D10 Determine the physics mechanisms leading to benign termination of RE with H and D, specifically in the ITER relevant parameter range
D11 Determine the physics mechanisms generating run-away electrons in the current quench, including during a vertical displacement event (VDE), and in the plasma start-up phase, including electron cyclotron (EC) pre-ionization and EC-assisted burn-through
D12 Perform interpretative modelling of disruption mitigation dynamics, specifically aiming at physics understandings of experimental measurements to extrapolate models to ITER (in collaboration with TSVV-F)
D13 Characterise disruption loads, in particular during VDEs, to improve predictions for ITER
D14 Investigate the role of plasma phenomena (turbulence, MHD, waves, fast ions etc) on the transport and confinement of REs

Scientific objectives and machine time

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Allocation of discharges (tentative)

	AUG	TCV	MAST-U	WEST
2027	35	110	0	15

Nominated Research Topic Coordinators:
O. Ficker, C. Reux, U. Sheikh, IO

WPTE Grant Deliverables and RT03 contribution

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
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

ID	Milestones Table	Date
TE.M.09	Proper figure of merit for cross-scenario comparison among no-ELM / ADC defined	Dec 2026
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

SPI related D8 and D9

D8: Develop an understanding of pellet assimilation for plasma densification in shattered pellet injection (SPI) experiments to avoid runaway electron (RE) generation → SPI assimilation

D9: Develop an understanding of SPI dynamics in off-normal plasmas, such as close to density limit and/or during impurity accumulation → SPI into “unhealthy” plasmas

EUROfusion and internal proposals

Topic	Proponent	Proposal	Selection
RE avoidance	Ansh Patel	Studying the plasmoid drift in AUG SPI experiments (EUROfusion)	Plasmoid
RE avoidance	Ansh Patel	Studying the plasmoid drift in AUG SPI experiments (Internal)	Plasmoid
RE avoidance	Stefan Jachmich	Viability of staggered and dual injection scheme for AUG SPI (EUROfusion)	Staggered
RE avoidance	Stefan Jachmich	Exploring multiple injection schemes for disruption mitigation with SPI (Int)	*No pulses*
RE avoidance	Umar Sheikh	SPI into strongly seeded plasmas (Internal)	***Postponed*** *(8 P2-pulses)*
RE avoidance	Paul Heinrich	Shattered pellet injection (SPI) fragment size effect (Internal)	*Fragm. size/frad (10 P1 pulses)*
RE avoidance	Ansh Patel	Shattered pellet injection (SPI) fragment size effect on pre-TQ duration (Int)	*(only 4 P2-pulses)*
RE avoid./Unh.plas.	Stefan Jachmich	Material assimilation in low Te plasma with AUG SPI (EUROfusion)	Post-TQ
Unhealthy plasmas	Ondrej Ficker	SPI into W-accumulation scenario at AUG (EUROfusion)	W-accumulation
Unhealthy plasmas	Peter Halldestam	Influence of background W on SPI (Internal)	*(4 P1 pulses) – but no time*
RE generation	Gergely Papp	Alternative runaway electron scenario for ASDEX Upgrade (EUROfusion)	***Postponed***
RE generation	Gergely Papp	Runaway electron generation with SPI (Internal)	*(only 4 P2-pulses)*
Commissioning	Gergely Papp	SPI commissioning and diagnostic optimisation	*(only 9 P2-pulses)*

Pulse execution (EuroFusion + internal)

- 36 pulses (not counting NSBs and aborted pulses): 31 good pulses, 5 with pellet issues

Note: not for all "good" pulses are all diagnostics available!

	Tasks	Attempted Pulses	Good pulses	Comment
	Fragment size effect on frad *(Internal)*	(7)	(6)	1x pellet stuck
	Plasmoid drift suppression	13+(4)	12+(4)	1x pellet stuck
	Staggered SPI	5	5	
	Impact of plasma instabilities (W-accumulation) on disruption mitigation with SPI	4	4	
	Post-TQ injection with different inj. geometry	3	0	2x "weird" pellet, 1x arrival too late
	Total:	**25**	**21**	

()=internal pulses

SPI related D8 and D9 (planned for 2027)

First priorities for 2027:

- Plasmoid drifts for N-doped pellets at low plasma energy (AUG)
- SPI into strongly impurities seeded plasmas (AUG)
- SPI in W-accumulation cases (AUG)
- Post TQ pellet injection (no heating is required) (AUG)

Runaways experiments in 2026

RT03 2026 RE Experiments

- 30 pulses for TCV done
- Limiterless compression explored -> led to fast VDEs
- Good data for ITER predictions where VDEs are expected
- Pure D2 beams generated for benign termination and plasma restart studies
- No pulses for REs this year on AUG due to MGI troubles
- 45 pulses on WEST to come – will target benign termination

Benign termination D10 & D12

Experiments

- Benign termination database developing well, now with D2 only data from TCV
- Metric for termination efficacy developed and applied to several tokamaks
- 45 pulses on WEST yet to come this year
- D2 data is excellent for modelling due to reduce complexity

Simulations yielding results:

- SOLPS-ITER: access to low ne is set by neutral energy conduction, ne rises again due to particle balance and increased RE energy transfer to companion plasma
- JOREK: Reduction in Te (and ne) leads to increased mode amplitude and growth

rate, which leads to stronger stochastization and RE expulsion

- Outlook: Complete database and modelling for benign termination. REMC and toroidal field ripple on TCV in 2027

Plans for 2027

First priorities for 2027 (with preliminary allocations):

- Benign at high pressure (#14 (AUG))
- RMC coil suppression #70 (TCV)
- WEST benign termination and start-up runaways (#15)
- TCV ripple effects on runaways #15
- TCV transport during runaways with new antenna #25

Plans for other proposals

Other priorities for 2027 remains the same as discussed a year ago

This includes:

- In-depth analysis of the unique JET disruptions
- Work on clarification of the hallo/hiro currents and associated disruption loads
- Modeling of the heat loads together with disruption loads