EUROfusion

05th uof November 2025

RT-06 “Preparation of efficient Plasma Facing Components (PFC) operation for ITER, DEMO and HELIAS”

Discussion on proposals and allocated priorities

E. Tsitrone

On behalf of WPTE TFLs
E. Tsitrone, N. Vianello, M. Baruzzo, V. Igochine, D. Keeling, A. Hakola, B. Labit

Research Topic Coordinators
Y. Corre, A. Kirschner, K. Krieger. Many thanks to A. Widdowson !
Reference TFL
E. Tsitrone, A. Hakola

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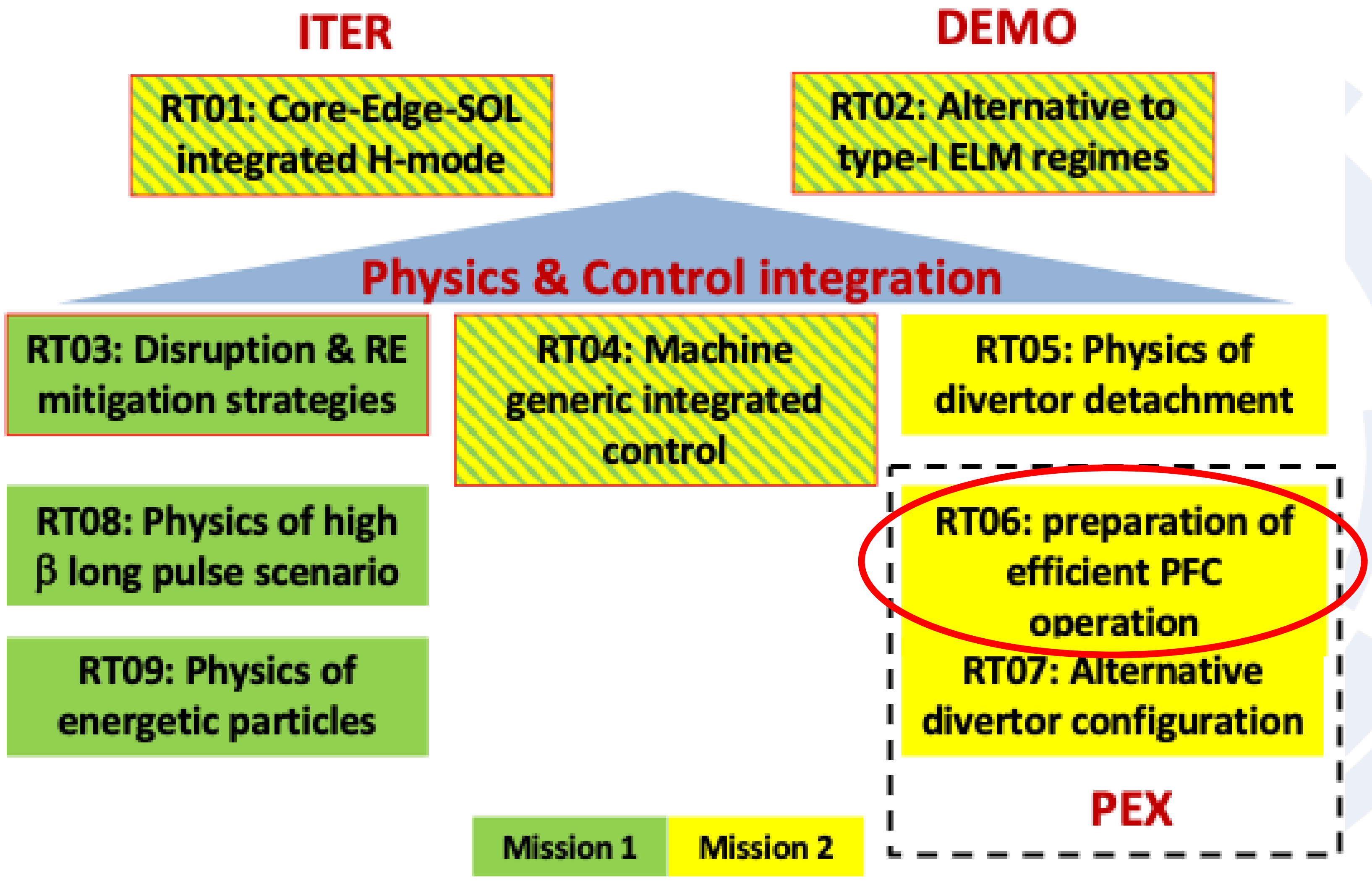
Introduction

- RT-06 is part of mission 2 on plasma exhaust, with a focus on the plasma facing components and PWI
- RT-06 is focussed on metallic devices (AUG, JET and WEST) for preparing next step fusion devices



Scientific Objectives of RT-06 : focus on ITER new baseline (W first wall + boronisation)

Scientific Objectives	
D1	Quantify local power load distributions on castellated and shaped PFCs for ITER and DEMO, including melting events
D2	Assess the impact of sustained high power / high particle fluence plasma exposure on the thermo-mechanical properties of metallic PFCs as well as on plasma operation
D3	Quantify material erosion sources from metallic walls under ITER relevant plasma conditions and determine material migration pathways, in particular to assess W sources from the first wall and the net erosion rates.
D4	Quantify fuel retention in devices with metallic walls, with a focus on long pulse operation, including the impact of boronisations and using laser-based diagnostics where available
D5	Assess fuel-removal efficiency in metallic devices, including the impact of boronisations and propose fuel removal procedures for next step metallic devices
D7	Assess the efficiency and lifetime of wall conditioning methods in metallic devices, with a focus on boronisation

2024 : D3 and D6 on material migation merged into D3 (D6 suppressed to avoid confusion)

Dedicated objective D7 added to address boronization related issues in 2024

2025 : further minor amendments

Scientific objectives of RT06 cover 3 R&D areas

Scientific Objectives	
D1	Quantify local power load distributions on castellated and shaped PFCs for ITER and DEMO, including melting events
D2	Assess the impact of sustained high power / … mechanical properties of metallic PFCs as well as on plasma operation
D3	Quantify material erosion sources from metallic walls under ITER relevant … determine material migration pathways, in particular to assess W sources … erosion rates.
D4	Quantify fuel retention in devices with metallic walls, with a focus on long pulse operation, including the impact of boronisations and using laser-based diagnostics where available.
D5	Assess fuel-removal efficiency in metallic … removal procedures for next step metallic …
D7	Assess the efficiency and lifetime of wall conditioning methods in metallic devices, with a focus on boronisation

PFC evolution / damage under plasma exposure

(Focus : impact of RE on first wall)

Material migration

(Focus : W first wall source)

Fuel retention / recovery and vessel conditioning (Focus : complete boronisation related work, GD for Dec 2026)

ID	*Deliverables Table*	*Date*
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

Proposal received : significant overbooking on AUG/WEST

Tentative allocation of discharges*

	AUG		TCV		MAST-U	WEST	
	2026	2027	2026	2027	2026	2026	2027
Tentative allocation*	24	32				150	90
Total proposed	99					804	
Overbooking	1,8					3,3	

* : to be reassessed after GPM

RT06 :
- largest share of TE experimental time on WEST,
- medium share of TE experimental time on AUG, as priority on upper divertor upgrade for Mission 2

RT06 specific features :
- Requests for divertor / midplane manipulators of AUG : to be coordinated
- Boronisation specific requests : boronisation set ups + regular reference pulses
- Close link to WP PWIE for post exposure PFC analysis and modelling

Overview of proposals : 27 proposals received, 3 R&D areas well covered

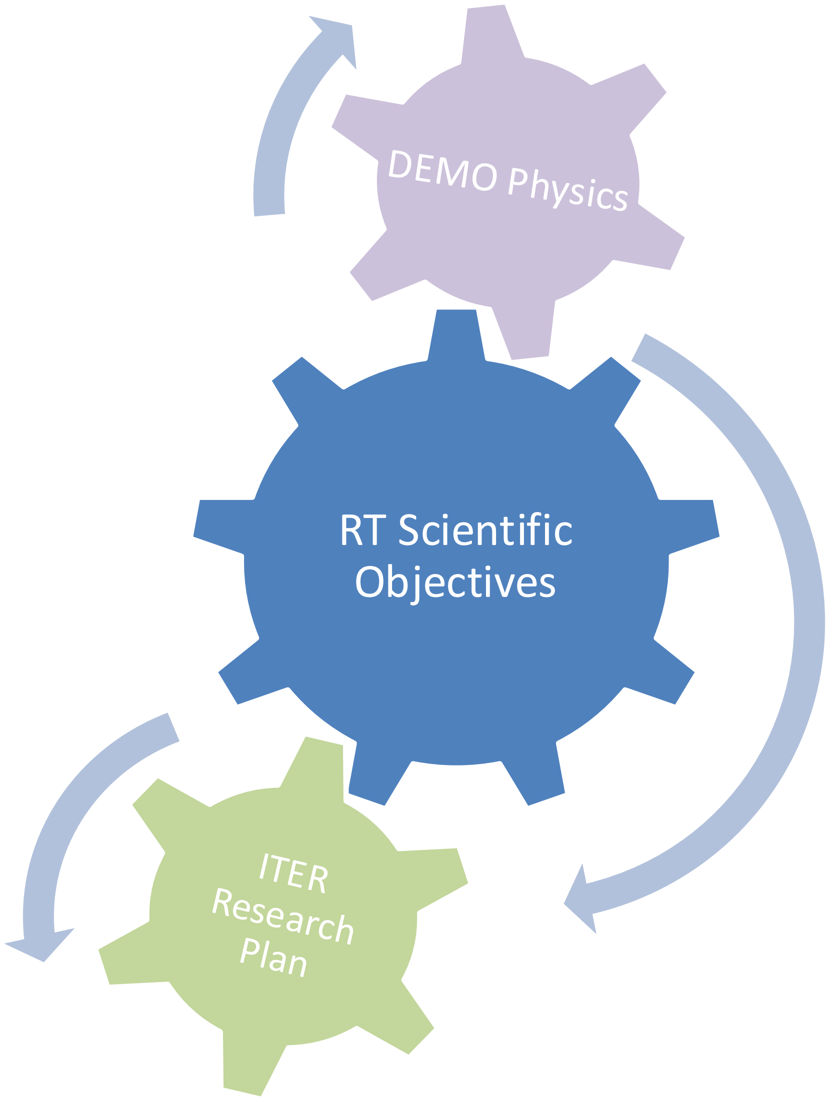
No	Proposal title	Main proponents
114	Multi-scale melt dynamics across PFC gaps	K. Krieger, S. Ratynskaia
115	Thermomechanical resilience of tungsten heavy alloys at high temperatures	K. Krieger, R. Pitts, S. Ratynskaia
116	W PFC damage induced by runaway electron incidence	...ia, K. Krieger, Y. Corre
134	Exposure of pre-damaged INTERFACE components	
135	Exposure of pre-damaged divertor components (pred#2	
118	Study of accelerated material damage under a high flue	...ut
136	Characterization of the heat load on castellated PFC: optical hot spot, toroidal gap and far SOL power width in WEST L-mode plasma	Y. Corre
121	Calorimetry power balance and ripple effect modulation	J. Gerardin
131	Low-Density ICRF + XPR Mitigation: Scenario development & Trade-off Study	G. Urbanczyk
132	Low-Density ICRF: Electron Heating & Impurity Transport Validation	G. Urbanczyk
119	Comparing W production and core plasma contamination by 2x2 strap Ion Cyclotron Antenna and Trav	... Lerche
130	TWA poloidal phase scan for impurity minimization in WEST	
133	LH Power Loss Characterization at high coupling with TWA	
138	Studying Ti/Te ratio and Ti decay length	
139	W-migration in lower X-point height geometries in WEST accounting for 3D realistic walls and magnetic geometry for the validation of tokamak boundary simulations	D. Sales de Oliveira
120	Effect of second harmonic ECH resonance on arcing risks inside the EC launcher	M. Schneider
117	Validation of the modelling of boron powder injection and boron film deposition	S. Ratynskaia, K. Krieger
127	Effect of spatially (non-)uniform boronization on plasma parameters, wall retention and B-rich layer properties	A. Gallo
128	Minimum boronization (B2D6 quantity) to restart WEST operations after a vent	A. Gallo
129	Boronization with and without glow discharge at various wall temperatures in WEST	A. Gallo
124	Development of ICWC boronization for ITER	E. Lerche, J. Hillairet
140	Preparation of B reference samples	
125	Particle balance in AUG as a measure of global D reter	
126	Estimation of H/D retention in boronized fusion devices	
122	Study about the outgassing of the deposit layer	
123	Impact of ICWC on plasma operation	... Hillairet
137	ICWC operation with TWA	R. Ragona

PFC evolution / damage under plasma exposure (D1, D2)

Material migration (D3)

Fuel retention / recovery and vessel conditioning (D4, D5, D7)

Prioritization scheme and criteria



Proposal Evaluated according to the criteria:

Adherence to the Scientific Objectives

Team effort

Size and feasibility

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

PFC evolution / damage under plasma exposure (D1/D2)

#114: Multi-scale melt dynamics across PFC gaps

➢ Proponents and contact person:

K. Krieger karl.krieger@ipp.mpg.de, S. Ratynskaia,
P. Tolias, Y. Corre, R. A. Pitts

➢ Scientific Background & Objectives

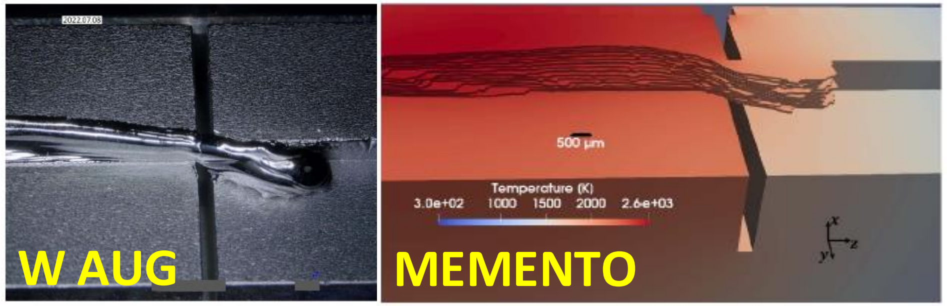
- Gap infiltration (JET, sustained melt) vs pure gap bridging (AUG, transient melt).
- The 2022 AUG gap melting exposure featured a W leading edge and led to transient melt pools.
- New AUG gap melting exposure to realize ITER-relevant case of sustained melt crossing a PFC gap (that avoids transient step-by-step bridging) at shallow inclination.

➢ Preparation

- AUG exposures were proposed in WPTE and prioritized for 2024/2025 but postponed due to technical issues.
- MEMENTO predictive modelling to optimize geometry, material composition and transient heat loads.
- Two castellated W samples of varying gap width already manufactured following the MEMENTO design guidelines.

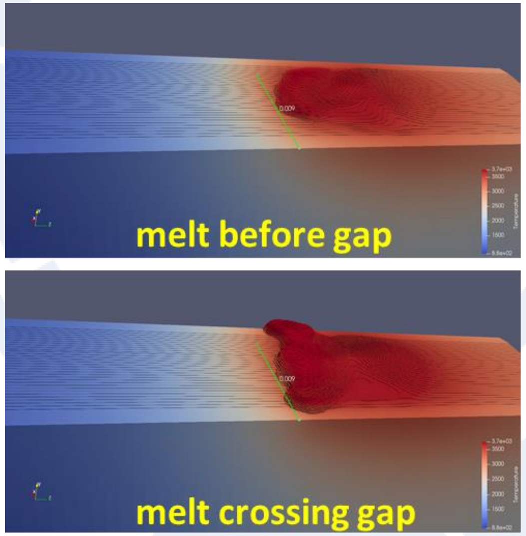
➢ Experimental / Essential diagnostic

- NBI+ECRH, ELMing H-mode, local sample instrumentation, IR/VIS observation cameras
- Detailed ex-situ analysis of macroscopic surface deformation, melt bridge and gap amassment.
- Modelling of large scale melt flows and final deformation profile with MEMENTO.
- Dimensionless fluid analysis of infiltration vs bridging regimes.



2022 AUG gap melt experiment: S. Ratynskaia, K. Paschalidis, K. Krieger et al., *Metallic melt transport across castellated tiles,* Nucl. Fusion 64, 036012 (2024).

Predictive modelling by MEMENTO



Device	# Pulses/Session	# Development
AUG	10	1-2

#114: Multi-scale melt dynamics across PFC gaps

Proponents and contact person:

K. Krieger karl.krieger@ipp.mpg.de, S. Ratynskaia,
P. Tolias, Y. Corre, R. A. Pitts

Priority: P1-AUG-26
Gap bridging under W melting : important topic for ITER
Re-submitted from 2025 (P1), was prepared but could not be executed

Scientific Background & Objectives

- Gap infiltration (JET, sustained melt) vs pure gap bridging (AUG, transient melt).
- The 2022 AUG gap melting exposure featured a W leading edge and led to transient melt pools.
- New AUG gap melting exposure to realize ITER-relevant case of sustained melt crossing a PFC gap (that avoids transient step-by-step bridging) at shallow inclination.

Preparation

- AUG exposures were proposed in WPTE and prioritized for 2024/2025 but postponed due to technical issues.
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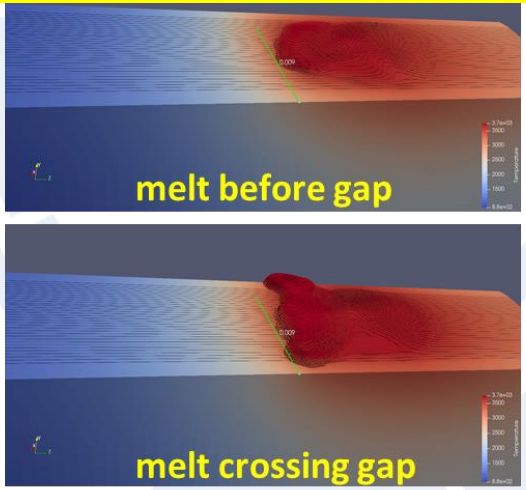


Device	# Pulses/Session	# Development
AUG	10	1-2

#115: Thermomechanical resilience of tungsten heavy alloys at high temperatures

➢ Proponents and contact person

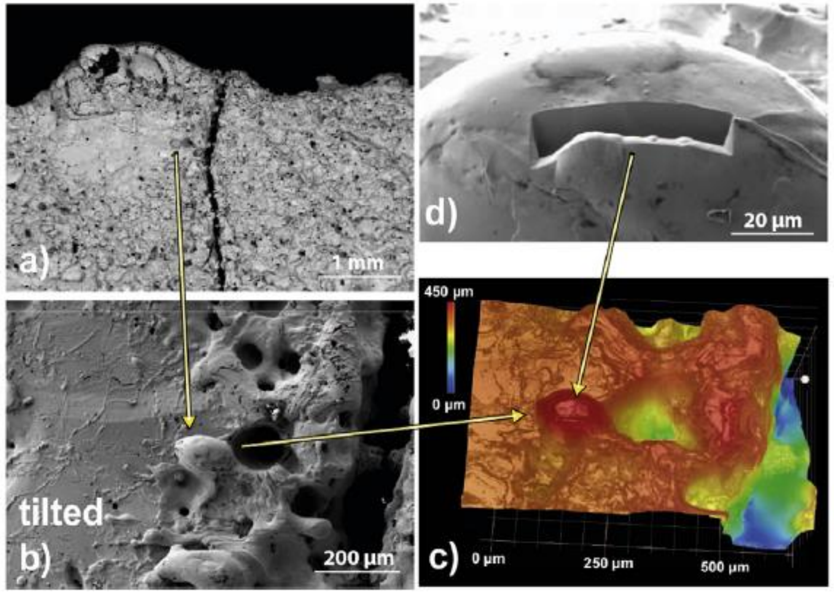
K. Krieger karl.krieger@ipp.mpg.de, R. A. Pitts, S. Ratynskaia,
R. Neu, P. Tolias

➢ Scientific Background & Objectives

- Due to their room temperature ductility, WHAs (W95NiCu, W97NiFe) are used as PFMs in current devices (AUG, W7-X) and considered as PFMs in future devices (ITER, SPARC).
- Unlike pure metallic melts, the WHA response to very high transient heat fluxes might be characterized by droplet ejection and irregular flows due to the admixtures.
- **Provide** experimental data for the WHA thermomechanical response to intense transient heat loads.
- **Model** melt motion with the MEMENTO code which includes the effects of admixtures in the thermophysical properties up to the binder phase melting point.
- **Check** whether any near-surface WHA cracking occurs in subsequent weak thermal excursions.

➢ Experimental Strategy & Essential diagnostic

- NBI+ECRH, ELMing H-mode, local sample instrumentation, IR/VIS observation cameras.
- Predictive modelling with MEMENTO to fine tune scenario.
- Detailed ex-situ analysis of surface deformation and near-surface composition.
- Modelling of large scale melt flows and final deformation profile with MEMENTO.
- High heat flux tests (e.g. GLADIS) to confirm resilience.



SEM (a,b), digital microscope (c) and FIB (d) investigation of the thermally overloaded part of a W97NiFe tile mounted in the divertor of AUG. Due to the accidental nature of the melting, there is no information on the incident heat flux and thus no evaluation of the maximum surface temperatures reached [R. Neu et al., J. Nucl. Mater. 511, 567 (2018)].

Device	# Pulses	# Development
AUG	5	Reference pulses to be identified from previous studies

#115: Thermomechanical resilience of tungsten heavy alloys at high temperatures

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K. Krieger karl.krieger@ipp.mpg.de, R. A. Pitts, S. Ratynskaia,
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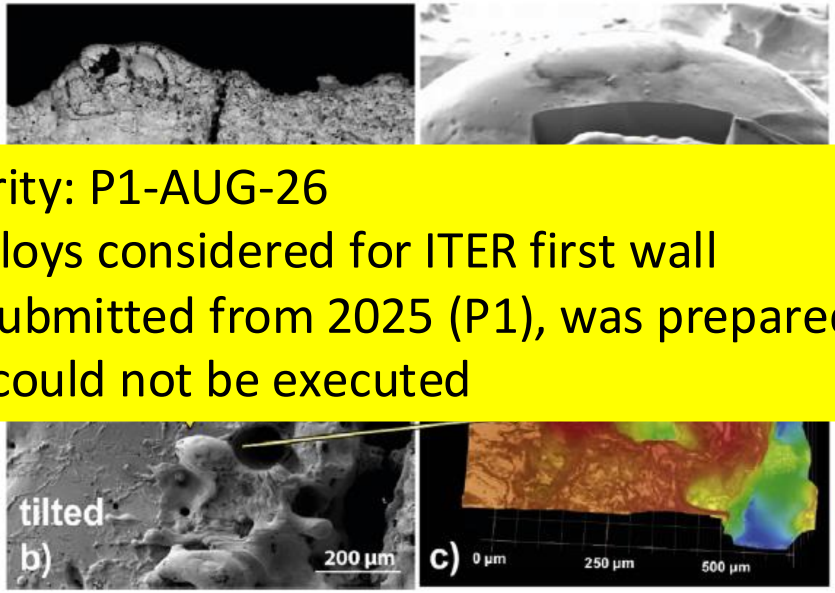
- High heat flux tests (e.g. GLADIS) to confirm resilience.

Priority: P1-AUG-26
W alloys considered for ITER first wall
Re-submitted from 2025 (P1), was prepared but could not be executed



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Device	# Pulses	# Development
AUG	5	Reference pulses to be identified from previous studies

#116: W PFC damage induced by runaway electron incidence

Proponents and contact person

S. Ratynskaia srat@kth.se, P. Tolias, K. Krieger, Y. Corre, M. Hoppe,
C. Reux, B. Sieglin, R. A. Pitts, V. Dimitriou, E. Kaselouris, G. Papp, E. Nardon, M. Hoelzl, E. Gauthier, J. Gerardin, M. Diez

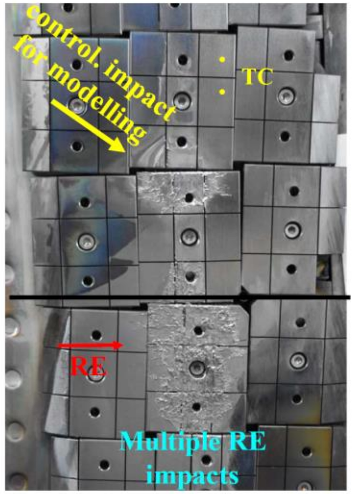
Scientific Background & Objectives

- RE impact leads to PFC explosion accompanied by the expulsion of fast solid dust which leads to wall cratering.
- RE-induced damage modelling has significantly advanced for graphite (benefitting from the multiple controlled DIII-D experiments) but lies at its infancy for tungsten.
- Empirical data from controlled W experiments necessary to understand the underlying physics and to validate the ongoing thermomechanical modelling effort.

Experimental Strategy & Essential diagnostic

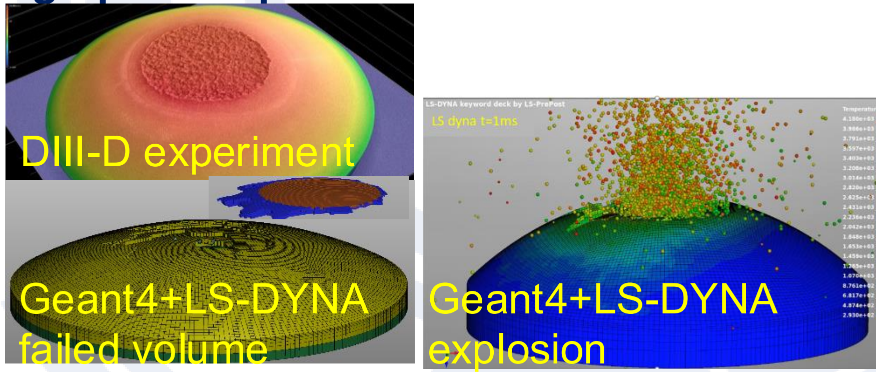
- First WEST experiment partially successful (the RE beam scraped the instrumented tile). Repeat in WEST & AUG.
- With lessons learnt from WEST & DIII-D experiments, expose smart W samples or tiles (TCs, shunt resistors).
- Observe evolution of PFC damage and extract size / speed of solid debris by IR/VIS cameras.
- Utilize witness plates to document impact cratering and compare with existing damage laws.
- Extensive post-mortem analysis including residual radioactivity and transmutation profiles.

***Validate** GEANT4+LS-DYNA workflow with **constrained RE input** from DREAM+SOFT codes and - later - from JOREK code*



Controlled damage of W tiles in WEST (April 2025). Feasibility of the exposures has been demonstrated, but REs barely deposited energy on the TC equipped W tile. Mounting of **multiple instrumented tiles will decrease the demand for extreme RE beam control.**

GEANT4+LS-DYNA modelling of RE-driven graphite explosions in DIII-D



Device	# Pulses	# Development
AUG	10-12	2-4 with reference pulses to be identified from previous studies
WEST	10	Reference pulses to be identified from previous studies

#116: W PFC damage induced by runaway electron incidence

Proponents and contact person

S. Ratynskaia srat@kth.se, P. Tolias, K. Krieger, Y. Corre, M. Hoppe,
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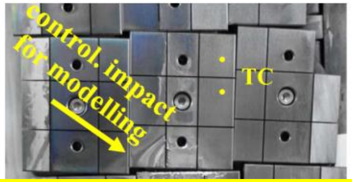
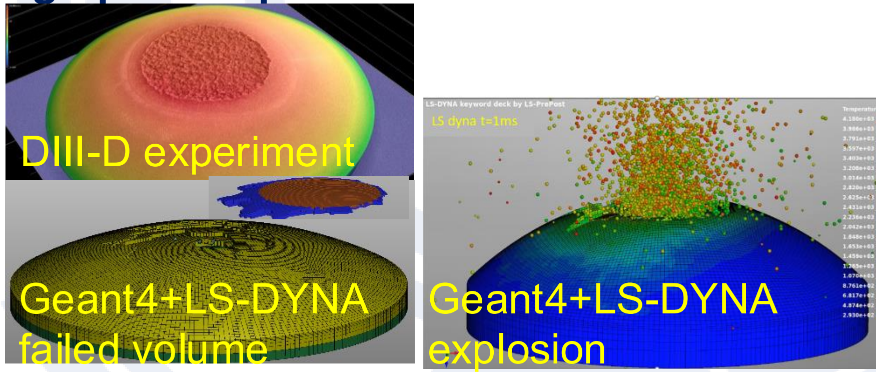


Controlled damage of W tiles in WEST (April 2025).
Feasibility of the exposures has
been demonstrated, but REs

Priority: P1-AUG-26 and P1-WEST-26
High priority for ITER first wall, first successful attempt in WEST in 2025
Technical feasibility still to be confirmed (MEM for AUG, multiple TC for WEST).
To be linked to PWIE for post mortem

graphite explosions in DIII-D

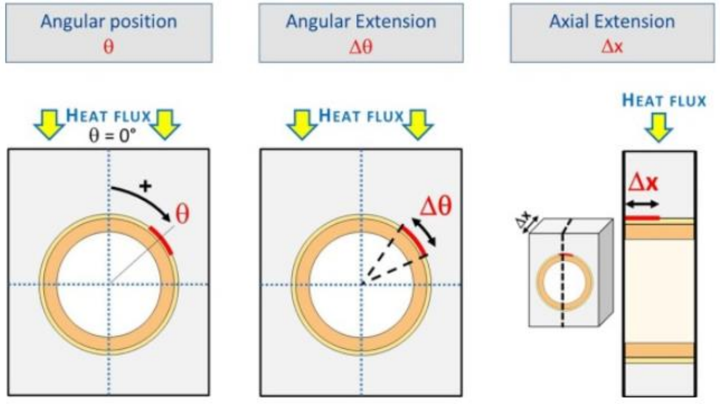


Device	# Pulses	# Development
AUG	10-12	2-4 with reference pulses to be identified from previous studies
WEST	10	Reference pulses to be identified from previous studies

#134: Exposure of pre-damaged INTERFACE components – follow-up

- **Proponents and contact person:**

A. Durif (alan.durif@cea,fr), M. Richou, Y. Corre, J. Gaspar, M. Missirlian, T. Wauters

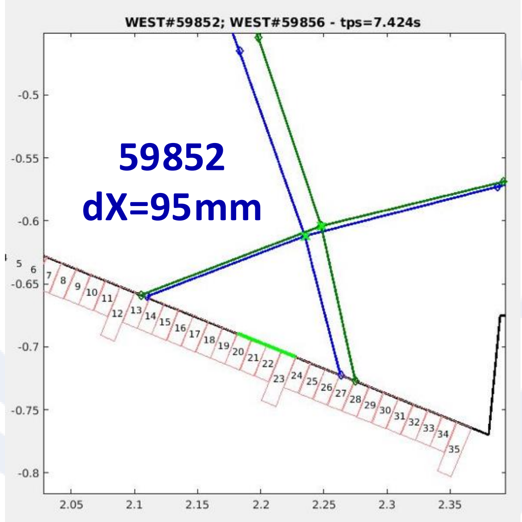


- **Scientific Background & Objectives**

Provide Structural Health Monitoring (**SHM**) keys for ITER/DEMO to **monitor** and **follow in real time** non expected hot spots related to internal PFU defects via IR diagnostics:

  - Precise the defect acceptance criteria for PFCs (θ, Δθ, ΔX)
  - "in-situ" hotspots monitoring → Reactor maintenance scheme optimization → SHM

  Experiment links with WPTE / WPDIV and ITPA / IO



- **Experimental Strategy/Machine Constraints and essential diagnostic**

Experiment achieved throughout dedicated sessions / plasma scenario baseline #59852/ Aim: positioned the strike line on MB13 at high injected power (>5 MW)

  - Density scan in LSN plasma with LH heating (potentially EC if available to expose the PFU to H-mode plasma)
  - Wide angle IR camera and spectrometer as essential diagnostic (PFU positioned in Q1B)

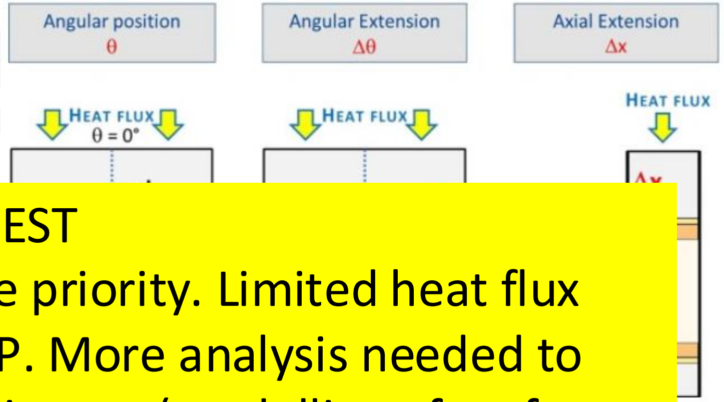
Proposed pulses

Device	# Pulses/ Session	# Development
WEST	30/2	Existing scenario

#134: Exposure of pre-damaged INTERFACE components – follow-up

- **Proponents and contact person:**

A. Durif (alan.durif@cea,fr), M. Richou, Y. Corre, J. Gaspar, M. Missirlian, T. Wauters



Priority: P2-WEST
#135 has more priority. Limited heat flux available at ISP. More analysis needed to prepare experiment (modelling of surface temperature for interface MB to check if defect detection possible)

- **Scientific Background & Objectives**

Provide Structural Health Monitoring (**SHM**) keys for ITER/DEMO to **moni** and **follow in real time** non expected hot spots related to internal PFU de via IR diagnostics:

  - Precise the defect acceptance criteria for PFCs (θ, Δθ, ΔX)
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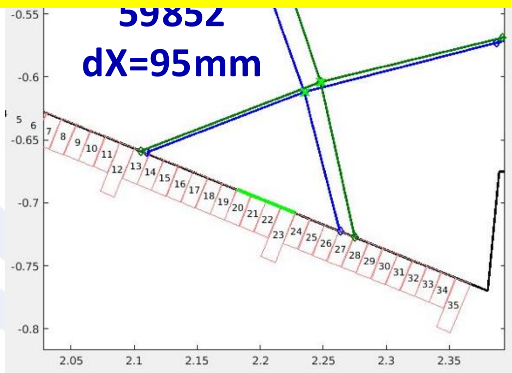
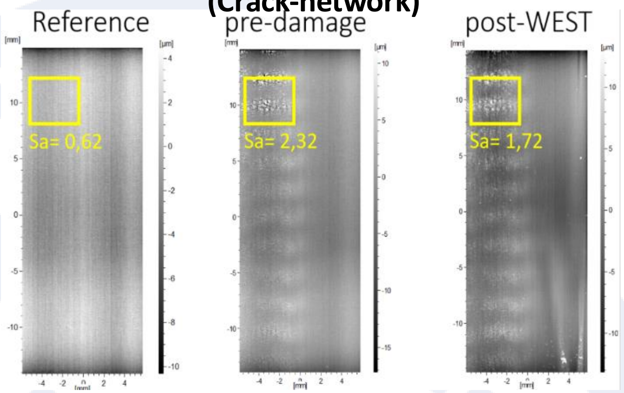


Proposed pulses

Device	# Pulses/ Session	# Development
WEST	30/2	Existing scenario

#135 : Exposure of pre-damaged ITER-like divertor component (pred#2 & #3) – follow-up

(Crack-network)



- **Proponents and contact person:**

A. Durif (alan.durif@cea.fr), Y. Corre, M. Richou, J. Gaspar, T. Wauters

- **Scientific Background & Objectives**

Assumption: ITER divertor lifetime >10 years - need for divertor components testing in tokamak environment, including damaged components. Operation with actively cooled ITER-like PFU with crack network and self-castellation

- Determine the impact of different kind of damages (crack network pred#2 MB25 and self-castellation pred#3 MB27) on power exhaust and plasma operation
- Assess the W source and temperature on the leading edge of the self-castellation and assess how the cracks propagates in W monoblock (MB)
- Assess consequences for plasma operation: determine the potential short and long term limitations (reduction of the power exhaust and consequently overheating of the damaged block)
- Characterize the surface texture evolution (confocal, X-ray tomography measurements) of pre-existing damages (comparative study)

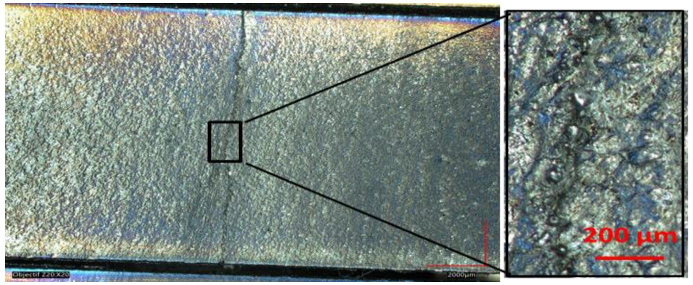
- **Experimental Strategy/Machine Constraints and essential diagnostic**

- Pred#2 located on PFU 7 (sector Q3B) for visible spectroscopy measurement and pred#3 MB27 (sector Q3B) give the opportunity to expose continuously the cracks to radiation only and specific session positioning the strike point on MB27 will allow direct plasma/heat loading steady state interactions (plasma scenario baseline #59852).
- Scan of the RF power: comparison W sources with OSP on MB26 (undamaged) and MB27 (self-castellated).

Self-castellation before C9 WEST campaign

[A. Durif et al., PFMC 2023]

Optical microscopy post C11 WEST campaign



Proposed pulses

Device	# Pulses/ Session	# Development
WEST	30/2	Existing scenario

#135 : Exposure of pre-damaged ITER-like divertor component (pred#2 & #3) – follow-up

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- Characterize the surface texture evolution (confocal, X-ray tomography measurements) of pre-existing damages (comparative study)

Priority: P1-WEST-26
Focus : complete self castellation high heat flux exposure before non destructive analysis of crack evolution

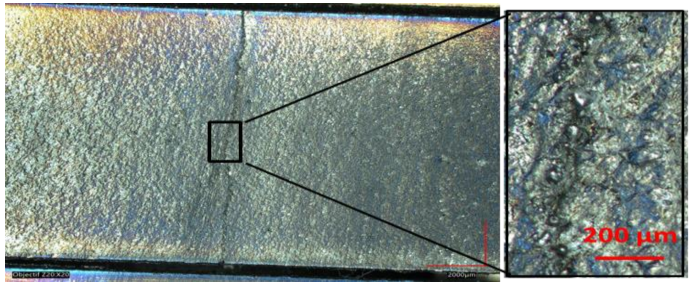
- **Experimental Strategy/Machine Constraints and essential diagnostic**

- Pred#2 located on PFU 7 (sector Q3B) for visible spectroscopy measurement and pred#3 MB27 (sector Q3B) give the opportunity to expose continuously the cracks to radiation only and specific session positioning the strike point on MB27 will allow direct plasma/heat loading steady state interactions (plasma scenario baseline #59852).
- Scan of the RF power: comparison W sources with OSP on MB26 (undamaged) and MB27 (self-castellated).

Self-castellation before C9 WEST campaign

[A. Durif et al., PFMC 2023]

Optical microscopy post C11 WEST campaign



Proposed pulses

Device	# Pulses/ Session	# Development
WEST	30/2	Existing scenario

#118 : Accelerated material damage under a high fluence of helium in WEST

- **Proponents**

C.Guillemaut, M. Richou, Y.Corre, A.Flament, M.Diez, C.Hernandez, E. Bernard, E.Hodille, C.Martin, E.Tsitrone, J.Gunn, J.Gerardin, J.Gaspar, E.Geulin, C.Jammes, E.Pawelec, K.Krieger, A.Widdowson, G.Ciraolo, H.Bufferand

- **Scientific Background & Objectives**
  - ITER will produce He during DT operations → crucial to study its specific impact on W PFC surfaces. The proposed experiment aims at reproducing the high particle fluence reached in 2023 on WEST (5×10^{26} D/m^{-2}) but with 100% He plasmas. This will allow:
  - ➢ isolating the effect of He on W PFC surfaces after a divertor fluence equivalent to several ITER discharges,
  - ➢ accelerating the effect of He on plasma facing materials since ITER DT plasmas will only have a He concentration of ~1%.
  - ➢ amplifying the W erosion and related damages in general since He provides an additional contribution to the sputtering of W
  - The objective is to provide feedback for ITER grade PFUs, 1st wall PFCs and exposed samples ageing/evolution under He particle fluence of up to ~10^{27} He/m^2.

- **Experimental Strategy / Machine Constraints and diagnostics**
  - Repeat of the same L-mode long pulse (1-2 min) for ~16 sessions in He → scenario developed from a reference from the previous 2019 He (low fluence) campaign (I_p ~ 300-500 kA, P_{LH} ~ 3-4 MW, n_l ~ 3-4 10^{19} m^{-2}) [Tsitrone NF 2022] to maximize duration and fluence.
  - High divertor T_e (~20-30 eV at SP) is preferred to accelerate the material damage under high fluence since growth erosion of W is orders of magnitudes higher in high T_e conditions than at the low T_e (~5 eV at SP) foreseen for ITER DT operations.
  - Analysis: post-mortem studies on PFCs and samples, diagnostic measurements (LP, IR, spectro., bolo…) and comparison with modelling (Soledge3X, ERO…)

Proposed pulses

Device	# Pulses/Session	# Development
WEST	16 Session / 240 pulses	1-2 sessions

#118 : Accelerated material damage under a high fluence of helium in WEST

- **Proponents**

  C.Guillemaut, M. Richou, Y.Corre, A.Flament, M.Diez, C.Hernandez, E. Bernard, E.Hodille, C.Martin, E.Tsitrone, J.Gunn, J.Gerardin, J.Gaspar, E.Geulin, C.Jammes, E.Pawelec, K.Krieger, A.Widdowson, G.Ciraolo, H.Bufferand

- **Scientific Background & Objectives**
  - ITER will produce He during DT operations → crucial to study its
    reproducing the high particle fluence reached in 2023 on WEST
  - ➢ isolating the effect of He on W PFC surfaces after a divertor flue
  - ➢ accelerating the effect of He on plasma facing materials since IT
  - ➢ amplifying the W erosion and related damages in general since
  - The objective is to provide feedback for ITER grade PFUs, 1st wa
    fluence of up to ~10^{27} He/m^2.

Priority: P2-WEST
Proposal to be refined : main interest would be change of thermo mechanical properties under He, which requires lower fluence than stated here. No high fluence foreseen in 26 if high fluence XPR run in 2025. Proposal for high fluence to be considered for 2027, but most interesting plasma conditions tbd, (presumably H mode in D if scenario available, rather than He)

- **Experimental Strategy / Machine Constraints an**
  - Repeat of the same L-mode long pulse (1-2 min) for ~16 sessions in He → scenario developed from a reference from the previous 2019 He (low fluence) campaign (I_p ~ 300-500 kA, P_{LH} ~ 3-4 MW, n_l ~ 3-4 10^{19} m^{-2}) [Tsitrone NF 2022] to maximize duration and fluence.
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  - Analysis: post-mortem studies on PFCs and samples, diagnostic measurements (LP, IR, spectro., bolo…) and comparison with modelling (Soledge3X, ERO…)

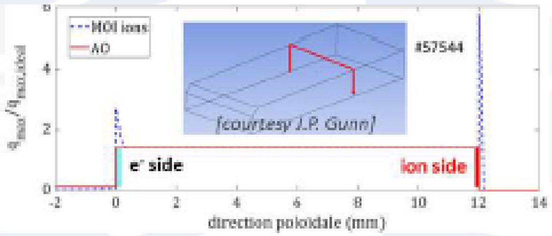
Proposed pulses

Device	# Pulses/Session	# Development
WEST	16 Session / 240 pulses	1-2 sessions

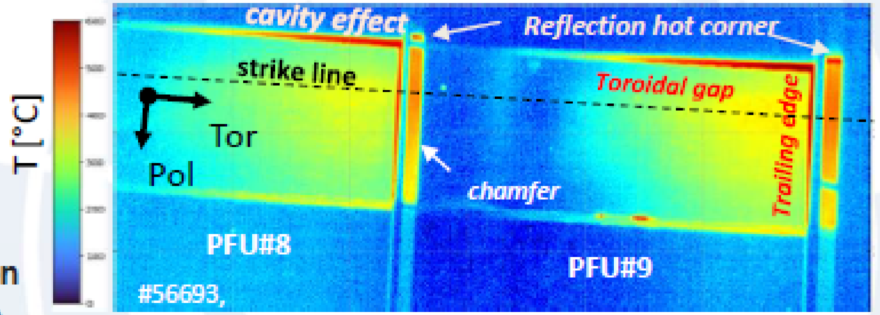
#136 : Characterisation of the heat load on castellated PFCs: optical hot spot, toroidal gap and far divertor SOL power width in L-mode plasmas (WEST)

- **Proponents and contact person:**
  - Y. Corre, M-H. Aumeunier, F. Cichocki, R. Dejarnac, J. Gaspar, J. Gerardin, J. Gunn, M. Diez, B. De Martino, A. Durif, M. Richou, M. Dimitrova, N. Fedorczak, J. Kovacic, A. Podolnik, N. Rivals, L. Schiesko, R. Mitteau

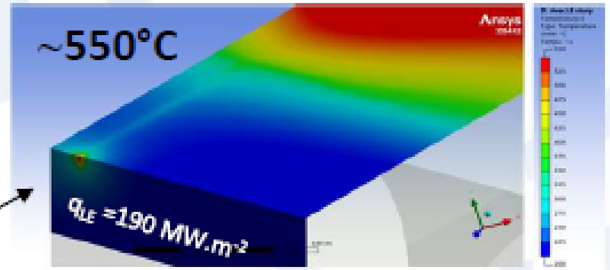
- **Scientific Background & Objectives**
  - Provide feedback for next step devices on operation with castellated components (ITER grade PFC)
  - Ion orbit model-based theory predicts **plasma deposition on both sides of toroidal gaps** between monoblocks if ion gyro-motion is accounted. Because of the toroidal gaps, magnetic field lines can also reach the sharp leading edge of the block with almost normal incidence leading to very high heat load deposited on small area, phenomenon called **Optical Hot Spots (OHS).**
    - Quantify the temperature increase on both toroidal edges (ion and e- sides) → **VHR IR camera**
    - Observe Optical Hot Spot (OHS) at the gap crossing and quantify their size.
    - Comparison of exp. data with the **optical approximation** and **ion orbit simulations for model validation**
    - Quantify far and near SOL power widths as function of SOL power and plasma collisionality (FBG system)



Very High spatial IR data [0.1 mm/pix]



OHS thermal response (nominal case - no misalignment)



- **Strategy**
  - **Modification of the WEST test divertor sector** (Q3B) is needed: PFU#8 should **have negative misalignment -0.3mm to minimize the specular reflection**. Use PFU with the 2mm groove on MB28 to derive the parallel heat flux in the far SOL power (see melting experiment in C9). Use RFA measurement to derive ionic temperature (input for PIC codes)
  - The high power scenario has already been developed in previous RT06 experiments (#57544). Low X point height (dX=45 mm) is proposed to get full use of the FBG system to measure the far SOL power width. Strike line in middle of the block to get VHR IR measurements on both sides of the blocks. **5 MW injected power** required to observe the OHS
  - In-situ measurement of the **W surface emissivity** is required (baking with two temperatures method)
  - Get at least two independent measurements of the parallel flux and **power decay length** (using embedded FBG diagnostics, LP and IR data).

link to WP TE RT05 (far SOL power), WPIE (post-mortem) and ITPA DivSOL (DSOL39)

Proposed pulses

Device	# Pulses/Session	# Development
WEST	30/2	10

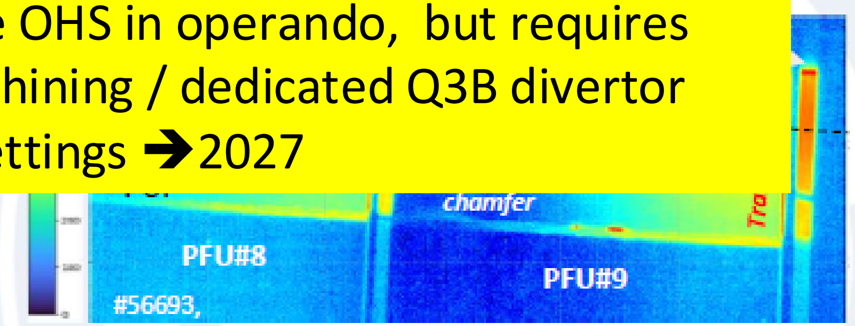
#136 : Characterisation of the heat load on castellated PFCs: optical hot spot, toroidal gap and far divertor SOL power width in L-mode plasmas (WEST)

- **Proponents and contact person:**

- Y. Corre, M-H. Aumeunier, F. Cichocki, R. Dejarnac, J. Gaspar, J. Gerardin, J. Gunn, M. Diez, B. De Martino, A. Durif, M. Richou, M. Dimitrova, N. Fedorczak, J. Kovacic, A. Podolnik, N. Rivals, L. Schiesko, R. Mitteau

Priority: P1-WEST-27
Nice idea building on previous results to evidence OHS in operando, but requires PFU machining / dedicated Q3B divertor sector settings ➔2027

- **Scientific Background & Objectives**
- Provide feedback for next step devices on operation with castellated components (ITER gra
- Ion orbit model-based theory predicts **plasma deposition on both sides of toroidal gaps** b monoblocks if ion gyro-motion is accounted. Because of the toroidal gaps, magnetic field li reach the sharp leading edge of the block with almost normal incidence leading to very hig deposited on small area, phenomenon called **Optical Hot Spots (OHS).**
  - Quantify the temperature increase on both toroidal edges (ion and e- sides) → **VHR IR camera**
  - Observe Optical Hot Spot (OHS) at the gap crossing and quantify their size.
  - Comparison of exp. data with the **optical approximation** and **ion orbit simulations for model validation**
  - Quantify far and near SOL power widths as function of SOL power and plasma collisionality (FBG system)



OHS thermal response (nominal case - no misalignment)

- **Strategy**
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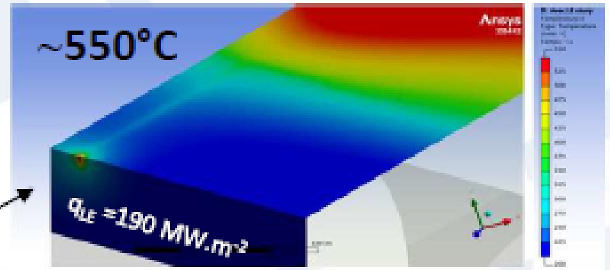


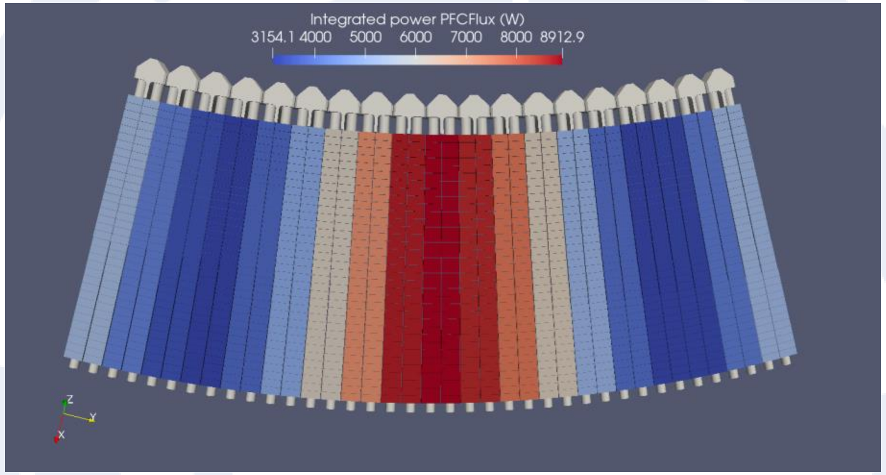
Proposed pulses

Device	# Pulses/Session	# Development
WEST	30/2	10

link to WP TE RT05 (far SOL power), WPIE (post-mortem) and ITPA DivSOL (DSOL39)

#121 : Calorimetry power balance and ripple effect modulation

- **Proponents and contact person:**
- Jonathan.gerardin@cea.fr
- Yann.corre@cea.fr
- Jonathan.gaspar@univ-amu.fr
- **Scientific Background & Objectives**
  - Almost all WEST PFCs are actively cooled and water temperature inside each group of PFCs is monitored, allowing calorimetry measurement for power balance.
  - The strong water flow leads to small increase of water temperature and large uncertainties of measurement (e.g 25% of uncertainties on extracted power from the lower divertor). The power balance is not closed yet (only 85% of the injected power is retrieved, a part is missing due to uncertainties)
  - The objective is to assess the power balance on WEST tokamak on a large set of reference scenarios, using a reduced water flow to increase the accuracy of the power balance.
  - New probes allow to perform calorimetry on pair of lower divertor W-PFU. Ripple modulation can be measured by these probes and compared with modelling.



- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Redo several existing reference scenarios of WEST with reduced cooling water flow :
    - High fluence, high fluence XPR, long pulse, high power, double null, upper single null
    - Duration : 30s-45s
    - At least 2MW of injected power, higher is better, depending on the scenario
  - Perform a scan of IP of a reference scenario to modify the ripple modulation on the lower divertor :
    - IP from 400kA to 600kA
    - Duration : 30s-45s
    - LH power : 4MW
  - Essential diagnostic : calorimetry

Proposed pulses

Device	# Pulses/Session	# Development
WEST	15 pulses	0

#121 : Calorimetry power balance and ripple effect modulation

- **Proponents and contact person:**
- Jonathan.gerardin@cea.fr
- Yann.corre@cea.fr
- Jonathan.gaspar@univ-amu.fr
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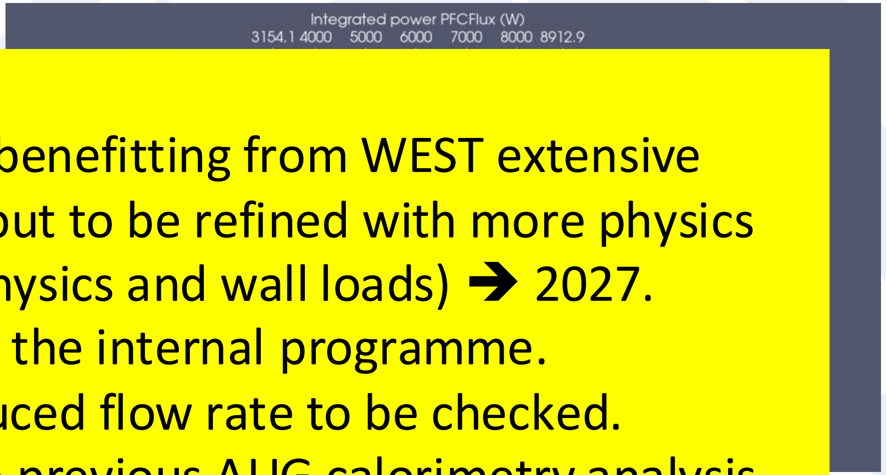

Priority: P1-WEST-27
Interesting proposal benefitting from WEST extensive calorimetry system, but to be refined with more physics objectives (far SOL physics and wall loads) ➔ 2027.
Ripple modulation to the internal programme.
Max power with reduced flow rate to be checked.
Add comparison with previous AUG calorimetry analysis.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Redo several existing reference scenarios of WEST with reduced cooling water flow :
    - High fluence, high fluence XPR, long pulse, high power, double null, upper single null
    - Duration : 30s-45s
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    - Duration : 30s-45s
    - LH power : 4MW
  - Essential diagnostic : calorimetry

Proposed pulses

Device	# Pulses/Session	# Development
WEST	15 pulses	0

Material migration (D3)

131 : Low-Density ICRF + XPR Mitigation: Scenario development & Trade-off Study

- **Proponents and contact person:**
  - Guillaume URBANCZYK (guillaume.urbanczyk@univ-lorraine.fr), Raymond Diab, Laurent Colas, Jamie Gunn

- **Scientific Background & Objectives**
  - Sheath Rectification Physics Across Lower-Hybrid Resonance.
    - Quantify scaling of rectified potentials (V_p) and W sputtering as SOL density crosses S=0.
    - Test hypothesis: weak rectification at low density reduces net limiter particle/heat flux despite high RF voltages
    - Validate fixed-voltage operation (22-28 kV) to decouple V_p from coupling variations
  - Coupling Optimization at Low Density.
    - Determine minimum antenna-plasma gap (ROG) yielding ≥250-500 kW at ≤28 kV with stable VSWR
    - Map coupling efficiency in propagative slow-wave regime ($n_e < n_{LH}$)
  - XPR Compatibility with Low-Density ICRF.
    - Demonstrate cold divertor operation ($T_{e,div}$ ≤3 eV) via N_2 seeding while maintaining low antenna-edge density
    - Demonstrate kinetic electron effects regularize S=0 resonance
    - Assess sensitivity to N_2 injection location (midplane vs. private zone) on W sources and core contamination
  - Geometry optimization.
    - Test triangularity (δ) scan at constant midplane gap to reduce antenna corner hot-spots
    - Identify optimal δ balancing coupling efficiency and plasma-wall interaction mitigation

Proposed pulses

Device	# Pulses/Session	# Dev
WEST	10 / 1	5

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Phase I - Baseline Characterization (Pulses 1-3, Ant. Q2) → Establish V_p-n_e trends crossing S=0 + Dynamic ROG scan (15→35 mm)
  - Phase II - XPR Integration (Pulses 4-5, Antenna Q2) → Demonstrate XPR formation with N_2 midplane injection & modulations (1 Hz)
  - Phase III - Shape Optimization (Pulses 6-7, Antenna Q2) → Triangularity scan: δ≈0.25 and δ≈0.55 at constant ROG + Compare corner heat loads via IR
  - Phase IV - Validation & Sensitivity (Pulses 8-10, Antenna Q1) → Reproduce best-case scenario on Q1 for symmetry check + N_2 location sensitivity test

  - **Diagnostics**: Emissive probe (Q3A or Q4B), RFA () (direct f(ε) measurements), visible spectro, Bolometry/interferometry, Reflectometry: S=0 layer tracking

131 : Low-Density ICRF + XPR Mitigation: Scenario development & Trade-off Study

- **Proponents and contact person:**
  - Guillaume URBANCZYK (guillaume.urbanczyk@univ-lorraine.fr), Raymond Diab, Laurent Colas, Jamie Gunn

- **Scientific Background & Objectives**
  - Sheath Rectification Physics Across Lower-Hybrid Resonance.
    - Quantify scaling of rectified potentials (V_p) and W sputtering as SOL density crosses S=0.
    - Test hypothesis: weak rectification at low density reduces net limiter particle/heat flux despite high RF
    - Validate fixed-voltage operation (22-28 kV) to decouple V_p from coupling variations
  - Coupling Optimization at Low Density.
    - Determine minimum antenna-plasma gap (ROG) yielding ≥250-500 kW at ≤28 kV with stable VSWR
    - Map coupling efficiency in propagative slow-wave regime ($n_e < n_{LH}$)
  - XPR Compatibility with Low-Density ICRF.
    - Demonstrate cold divertor operation ($T_{e,div}$ ≤3 eV) via N_2 seeding while maintaining low antenna-edge density
    - Demonstrate kinetic electron effects regularize S=0 resonance
    - Assess sensitivity to N_2 injection location (midplane vs. private zone) on W sources and core contamination
  - Geometry optimization.
    - Test triangularity (δ) scan at constant midplane gap to reduce antenna corner hot-spots
    - Identify optimal δ balancing coupling efficiency and plasma-wall interaction mitigation

Priority: P2-WEST
Requires challenging scenario development (low ne vs XPR, XPR with ICRH only …). Can it be done in AUG more easily ?

Proposed pulses

Device	# Pulses/Session	# Dev
WEST	10 / 1	5

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Phase I - Baseline Characterization (Pulses 1-3, Ant. Q2) → Establish V_p-n_e trends crossing S=0 + Dynamic ROG scan (15→35 mm)
  - Phase II - XPR Integration (Pulses 4-5, Antenna Q2) → Demonstrate XPR formation with N_2 midplane injection & modulations (1 Hz)
  - Phase III - Shape Optimization (Pulses 6-7, Antenna Q2) → Triangularity scan: δ≈0.25 and δ≈0.55 at constant ROG + Compare corner heat loads via IR
  - Phase IV - Validation & Sensitivity (Pulses 8-10, Antenna Q1) → Reproduce best-case scenario on Q1 for symmetry check + N_2 location sensitivity test
  - **Diagnostics**: Emissive probe (Q3A or Q4B), RFA () (direct f(ε) measurements), visible spectro, Bolometry/interferometry, Reflectometry: S=0 layer tracking

#132 : Low-Density ICRF: Electron Heating & Impurity Transport Validation

- **Proponents and contact person:**
  - Guillaume URBANCZYK (guillaume.urbanczyk@univ-lorraine.fr), Leonel Tsowemoo-faabomve, Raymond Diab, Laurent Colas, Jamie Gunn, Volodymyr BOBKOV, Roman OCHOUKOV, Ralph Dux, Wouter Tierens, Atul Kumar, Stéphane Heuraux, Jérôme Moritz

- **Scientific Background & Objectives**
  - **Measure Electron Heating Mechanism at Low density**
    - Direct measurement of electron distribution functions f(ε) via RFA across $\tau_e/\tau_{RF} \approx 0.1\text{-}10$
    - Validate PIC predictions: ΔT_e ~ 50-100 eV enhancement when $n_e \approx n_{low}$ (resonant heating condition)
    - Test frequency scaling: $n_{low} \propto \omega^2$ by scanning ICRF frequency (WEST: 55-57 MHz; AUG: 30-36.5 MHz)
  - **Confirm Enhanced Impurity Redeposition at Low Density**
    - Measure penetration factors $\eta_{pen} = \Phi_{core}/\Gamma_{gross}$ across density regimes (challenging for W in WEST but OK for Mo in AUG)
    - Test $\lambda_{ion} < s$ criterion: when ionization occurs within expanded sheath, prompt redeposition dominates
    - Expected transition: η_{pen} ~ 0.3-0.5 (high n_e) → 0.05-0.15 (low n_e) representing order-of-magnitude reduction in net erosion
  - **Lower-Hybrid Singularity Resolution**
    - Explain benign AUG observation: no deleterious effects when slow wave propagative ($n_e < n_{LH}$)
    - Hypothesis: kinetic electron heating regularizes S=0 singularity via modified dielectric response
    - Critical for ITER scenarios with local gas puffing near antennas

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - **WEST (L-mode, LSN, 550-650 kA, 3.7 T, reference shots #61403-16)**
    - 10 discharges systematically scanning density, ROG, ICRF power, triangularity
    - RFA probe + W-I spectroscopy for electron heating & erosion measurements
    - N_2 seeding for XPR to isolate antenna sources
  - **AUG (H-mode, LSN, 800 kA, 2.5 T, reference shot #37963)**
    - 6 discharges with Mo-tracer tiles at antenna limiters
    - Density ramp crossing n_{LH} and n_{low} thresholds
    - Matched high/low density comparisons with RF power scans
    - Local gas injection test (ITER-relevant scenario)
  - **Diagnostics**
    - RFA: f(ε) measurements (multiple plunges/discharge)
    - Visible spectroscopy: Gross erosion (W-I/Mo-I lines)
    - UV spectroscopy: Core influx (W continuum in WEST / Mo^{31+}-Mo^{32+} in AUG)
    - Langmuir/emissive probes: Local n_e, T_e, V_p profiles
    - Reflectometry: S=0 layer tracking

Proposed pulses

Device	# Pulses/Session	# Dev
AUG	6	1
WEST	10 / 1	5

#132 : Low-Density ICRF: Electron Heating & Impurity Transport Validation

- **Proponents and contact person:**
  - Guillaume URBANCZYK (guillaume.urbanczyk@univ-lorraine.fr), Leonel Tsowemoo-faabomve, Raymond Diab, Laurent Colas, Jamie Gunn, Volodymyr BOBKOV, Roman OCHOUKOV, Ralph Dux, Wouter Tierens, Atul Kumar, Stéphane Heuraux, Jérôme Moritz

- **Scientific Background & Objectives**
  - **Measure Electron Heating Mechanism at Low density**
    - Direct measurement of electron distribution functions f(ε) via RFA across $\tau_e/\tau_{RF} \approx 0.1$-10
    - Validate PIC predictions: $\Delta T_e \sim 50$-100 eV enhancement when $n_e \approx n_{low}$ (resonant heating condition)
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    - Explain benign AUG observation: no deleterious effects when slow wave propagative ($n_e < n_{LH}$)
    - Hypothesis: kinetic electron heating regularizes S=0 singularity via modified dielectric response
    - Critical for ITER scenarios with local gas puffing near antennas

Priority: P2-AUG, P2-WEST
Slow wave ICRH propagation could happen in ITER, higher priority than #131 but propose to focus on analysis of AUG experiments with Mo antenna tiles performed in 2025 before granting additional experimental time

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - **WEST (L-mode, LSN, 550-650 kA, 3.7 T, reference shots #61403-16)**
    - 10 discharges systematically scanning density, ROG, ICRF power, triangularity
    - RFA probe + W-I spectroscopy for electron heating & erosion measurements
    - N_2 seeding for XPR to isolate antenna sources
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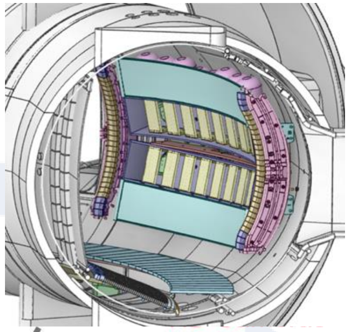
    - Reflectometry: S=0 layer tracking

Proposed pulses

Device	# Pulses/Session	# Dev
AUG	6	1
WEST	10 / 1	5

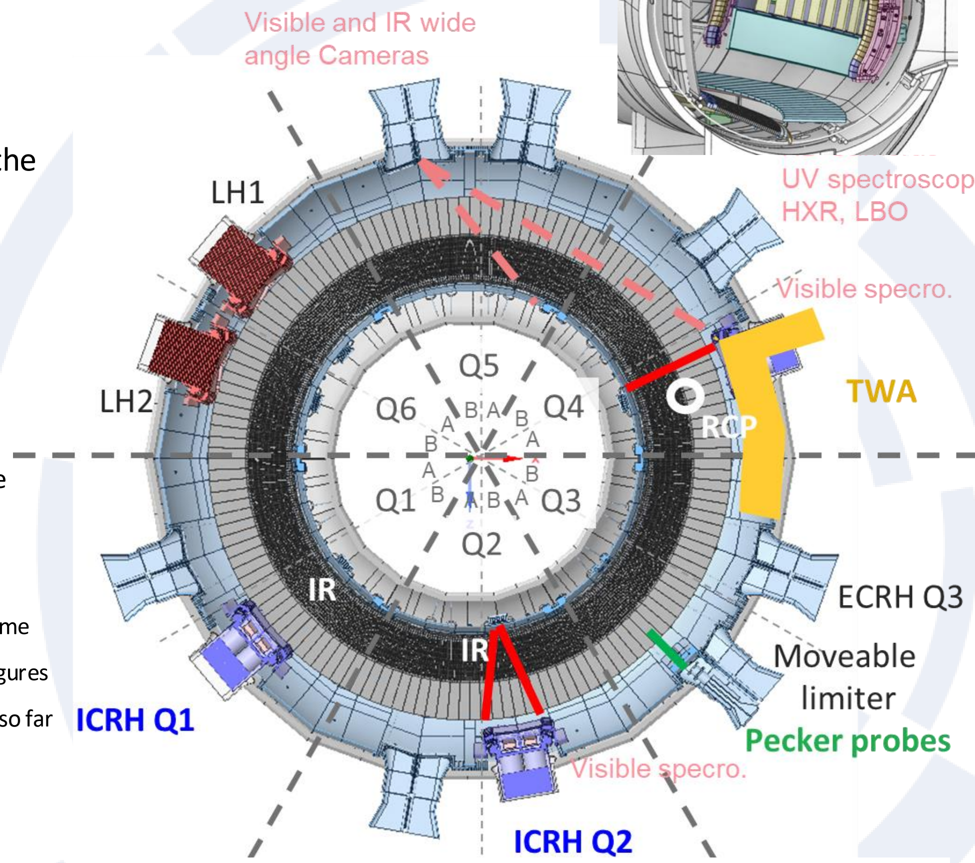
#119 : Comparing W production and core plasma contamination strap Ion Cyclotron Antenna and Travelling Wave Array



- **Proponents and contact person:** **Part of ITPA IOS and DSOL**

L. Colas, E.Lerche, J. Hillairet, R. Ragona, V. Maquet, R. Diab, G. Urbanczyk, W. Tierens.

- **Scientific Background & Objectives**
  - In present-day full-metal magnetic Fusion devices, most of the high-Z impurity influx contaminating the core plasma arises from the low-field side of the main chamber. Ion Cyclotron antennas are located there and enhance the wall erosion via RF sheath rectification.
  - In next-step devices, it is important to find optimal strategies to operate these ICRF systems. This optimization often boils down to a trade-off between power coupling and W contamination.
  - A Travelling Wave Array is attractive in this prospect.
    - For the same coupled power and similar antenna position, the TWA is expected to excite lower rectified potentials compared to classic
    - the TWA is supposed to excite efficiently the fast wave from radial positions far way from the separatrix, where the particle fluxes onto the antenna structures are low.
    - Increasing the antenna / plasma gap also reduces the impurity penetration.
  - Objectives:
    - Direct comparison of impurity production and core plasma contamination by RF-sheath rectification from different antenna types on the same plasma, using visible spectroscopy, emissive probes and core plasma measurements.
    - Determine a distance antenna / separatrix that offers the best trade-off between power coupling capabilities and plasma contamination. Figures of merit could be maximal $P_{coupled}$-P_{rad} or maximal W_{MHD}. Optimal setting may depend on the antenna type.
    - Check for any detrimental plasma-wall interaction associated with LH resonance and/or propagative Slow Wave. No sign of such effect was so far detected with classical antennas.
    - Validate RF-sheath modelling of classical and TWA IC wave launchers.
- **Exp. Strategy/Machine Constraints and diagnostics**
  - LSN L-mode plasma of interest for scenario development.
  - Toggle TWA top, TWA bottom and classical 2×2-strap arrays (Q2 equipped with visible spectroscopy, Q1 connected to RCP) at same coupled power levels and side limiter radial position.
  - Scan the plasma external radius on a pulse to pulse basis, hence the local density at the antennas, across the Lower Hybrid resonant layer, below which the Slow Wave becomes propagative.

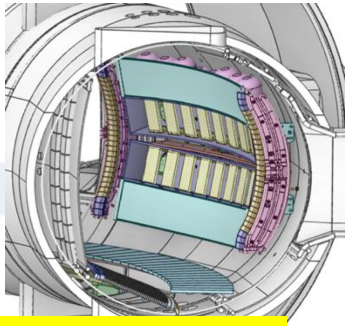


Planned antenna & diag. setup for WEST in 2027

Proposed pulses

Device	# Pulses/Session	# Development
WEST	1 Session (2027)	Scenario is ready

#119 : Comparing W production and core plasma contamination strap Ion Cyclotron Antenna and Travelling Wave Array

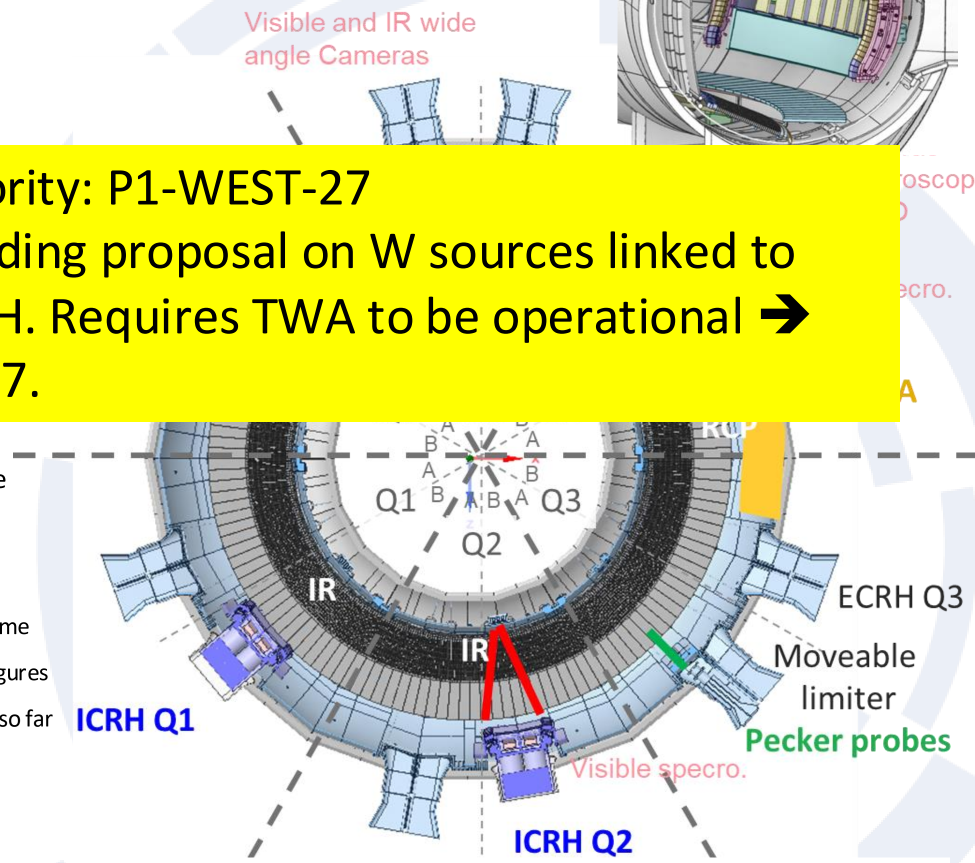


- **Proponents and contact person:** **Part of ITPA IOS and DSOL**

L. Colas, E.Lerche, J. Hillairet, R. Ragona, V. Maquet, R. Diab, G. Urbanczyk, W. Tierens.

- **Scientific Background & Objectives**
  - In present-day full-metal magnetic Fusion devices, most of the high-Z impurity influx contamin core plasma arises from the low-field side of the main chamber. Ion Cyclotron antennas are lo there and enhance the wall erosion via RF sheath rectification.
  - In next-step devices, it is important to find optimal strategies to operate these ICRF systems. T optimization often boils down to a trade-off between power coupling and W contamination.
  - A Travelling Wave Array is attractive in this prospect.
    - For the same coupled power and similar antenna position, the TWA is expected to excite lower rectified po compared to classic
    - the TWA is supposed to excite efficiently the fast wave from radial positions far way from the separatrix, where the particle fluxes onto the antenna structures are low.
    - Increasing the antenna / plasma gap also reduces the impurity penetration.
  - Objectives:
    - Direct comparison of impurity production and core plasma contamination by RF-sheath rectification from different antenna types on the same plasma, using visible spectroscopy, emissive probes and core plasma measurements.
    - Determine a distance antenna / separatrix that offers the best trade-off between power coupling capabilities and plasma contamination. Figures of merit could be maximal $P_{coupled}$-P_{rad} or maximal W_{MHD}. Optimal setting may depend on the antenna type.
    - Check for any detrimental plasma-wall interaction associated with LH resonance and/or propagative Slow Wave. No sign of such effect was so far detected with classical antennas.
    - Validate RF-sheath modelling of classical and TWA IC wave launchers.

Priority: P1-WEST-27
Leading proposal on W sources linked to ICRH. Requires TWA to be operational ➔ 2027.



Planned antenna & diag. setup for WEST in 2027

- **Exp. Strategy/Machine Constraints and diagnostics**
  - LSN L-mode plasma of interest for scenario development.
  - Toggle TWA top, TWA bottom and classical 2×2-strap arrays (Q2 equipped with visible spectroscopy, Q1 connected to RCP) at same coupled power levels and side limiter radial position.
  - Scan the plasma external radius on a pulse to pulse basis, hence the local density at the antennas, across the Lower Hybrid resonant layer, below which the Slow Wave becomes propagative.

Proposed pulses

Device	# Pulses/Session	# Development
WEST	1 Session (2027)	Scenario is ready

#130 : Travelling Wave Array poloidal phase scan for impurity minimization in WEST

Proponents

V. Maquet, W. Tierens, J. Hillairet, R. Ragona, L. Colas,G. Urbanczyk, R. Dumont, E. Lerche, D. Van Eester, et al

Scientific Objectives

The TWA will have the unique capability to control the poloidal phasing between the top and bottom rows of strap arrays:

- On the edge, this should allow for potential sheath reductions and increased power coupling.
- On the core, it could impact the heating efficiency.
- If an active poloidal phase control is possible, this feature could also be used to spread the power deposition profile, reducing the population of non-confined fast-ions, allowing an increased ion-heating efficiency.

Experimental Strategy

- Make a scan of the poloidal phase between top and bottom rows
- For the edge: good PWI coverage (edge spectroscopy, divertor diagnostics, ...)
- For the core: Power modulations and/or breaks in slope to assess off-axis power deposition

Proposed pulses

Device	# Pulses/Session	# Development
WEST	15 pulses /1 session	

#130 : Travelling Wave Array poloidal phase scan for impurity minimization in WEST

Proponents

V. Maquet, W. Tierens, J. Hillairet, R. Ragona, L. Colas,G. Urbanczyk, R. Dumont, E. Lerche, D. Van Eester, et al

Priority: to be merged with # 119

Scientific Objectives

The TWA will have the unique capability to control the poloidal phasing between the top and bottom rows of strap arrays:

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Proposed pulses

Device	# Pulses/Session	# Development
WEST	15 pulses /1 session	

#133 : TWA LH Power Loss Characterization

Proponents

V. Maquet, W. Helou, J. Hillairet, R. Ragona, L. Colas, R. Diab, E.Lerche, G. Urbanczyk, W. Tierens, E. Lerche, et al.

Scientific Objectives

TWA will have the unique capability to couple a large amount of power in low density regimes:

- Enable the possibility to study ITER relevant low density scenarios where a non-negligible amount of power will be directly lost in the LH resonance (in ITER this could represent around 10% of the power coupled even in favorable toroidal phasing (0pipi0 and 0pi0pi))

Experimental Strategy

- Measure edge electron temperature profile to see local increase in edge temperature .
- The TWA will come with the possibility to change the poloidal phasing, changing the amount of power launched into so-called coaxial modes. This gives the opportunity to study the possibility to effectively reduce that effect by varying the total spectrum launched by the antenna.
- Local gas injection to tailor the density profiles in the far SOL (predicted to change the edge power deposition)

The experiment will build upon RT06 proposals: Comparing W production and core plasma contamination by 2x2 strap Ion Cyclotron Antenna and Travelling Wave Array.

Proposed pulses

Device	# Pulses/Session	# Development
WEST	15 pulses /1 session	

#133 : TWA LH Power Loss Characterization

Proponents

<u>**V. Maquet**</u>, W. Helou, J. Hillairet, R. Ragona, L. Colas, R. Diab, E.Lerche, G. Urba

Priority: P2-WEST
Less priority than #119 (W source focus)

Scientific Objectives

TWA will have the unique capability to couple a large amount of power in low density regimes:

- Enable the possibility to study ITER relevant low density scenarios where a non-negligible amount of power will be directly lost in the LH resonance (in ITER this could represent around 10% of the power coupled even in favorable toroidal phasing (0pipi0 and 0pi0pi))

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The experiment will build upon RT06 proposals: Comparing W production and core plasma contamination by 2x2 strap Ion Cyclotron Antenna and Travelling Wave Array.

Proposed pulses

Device	# Pulses/Session	# Development
WEST	15 pulses /1 session	

#138 : Studying Ti/Te ratio and Ti decay length

RT06: Preparation of efficient Plasma Facing Components (PFC) operation for ITER, DEMO and HELIAS

- **Proponents and contact person:**
- Jernej Kovačič (jernej.kovacic@fs.uni-lj.si), Miglena Dimitrova, Pavlina Ivanova, Bianca De Martino, Jamie Gunn, Tomaž Gyergyek

- **Scientific Background & Objectives**
- Divertor Ti crucial missing component in heat and erosion calculations
- Obtain local divertor Ti and Te values and define Ti/Te ratio in ohmic and LH plasmas in WEST tokamak
- Quantify Ti decay length for pure ohmic and LH heated plasma at various densities in WEST tokamak

- **Experimental Strategy/Machine Constraints and essential diagnostic**
- Density scan with LSN at fixed P_{ohm}/P_{LH}
- RFA is fixed at MB#28/#29-> use fixed strike point with density ramp
- Next shot move the strike point position to obtain radial profile of Ti/Te
- 4-5 radial points needed to define Ti decay length
- Needed: RFA + LP + Pecker probes + IR

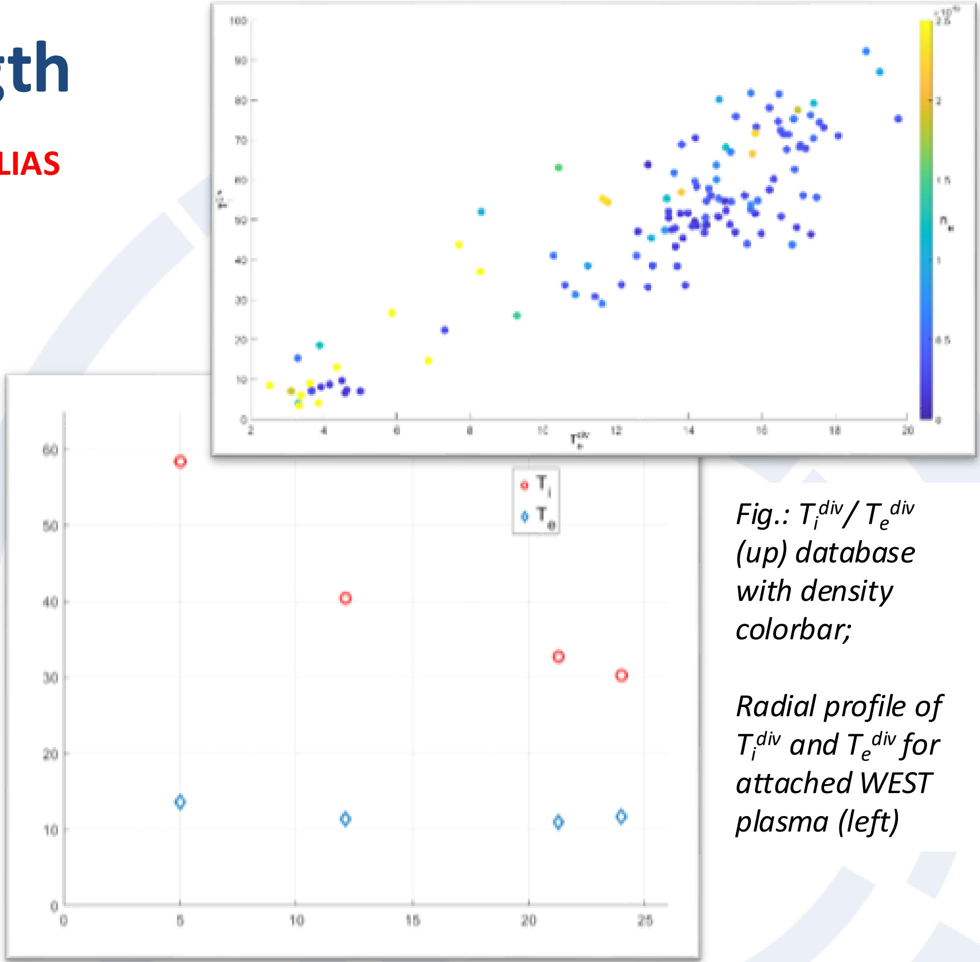

Fig.: T_i^{div}/ T_e^{div} (up) database with density colorbar;

Radial profile of T_i^{div} and T_e^{div} for attached WEST plasma (left)

Proposed pulses

Device	# Pulses/Session	# Development
AUG	-	-
MAST-U	-	-
WEST	**20 pulses / 2 sessions**	**4 pulses**

#138 : Studying Ti/Te ratio and Ti decay length

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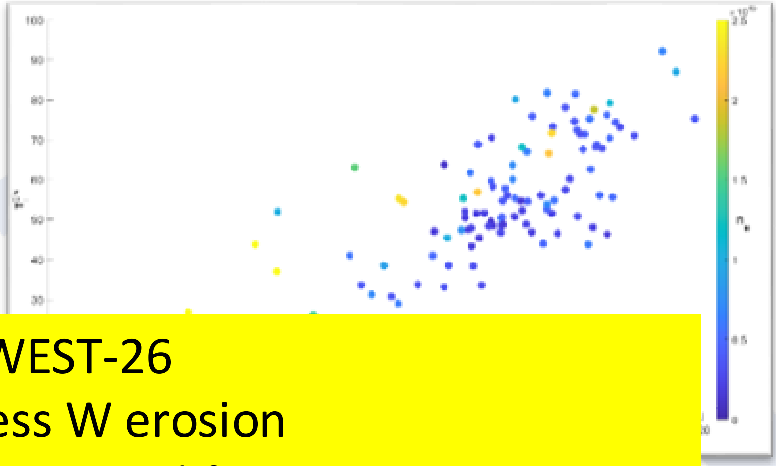
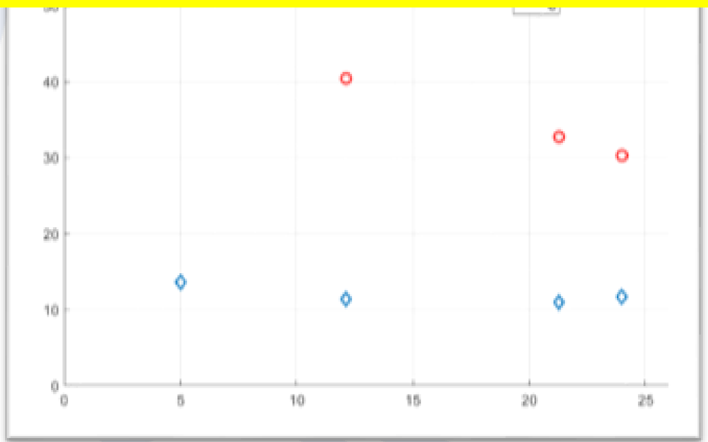


Priority: P1-WEST-26
Ti key to assess W erosion
Link to RT05 proposal for Ti in XPR



(up) database with density colorbar;

Radial profile of T_i^{div} and T_e^{div} for attached WEST plasma (left)

Proposed pulses

Device	# Pulses/Session	# Development
AUG	-	-
MAST-U	-	-
WEST	20 pulses / 2 sessions	4 pulses

#139 : W-migration in lower X-point height geometries in WEST accounting for 3D realistic walls and magnetic geometry for the validation of tokamak boundary simulations

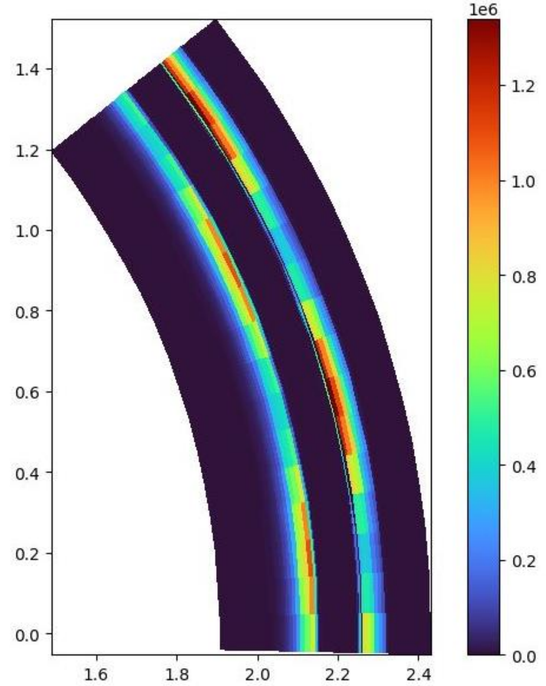
- **Proponents and contact person:**

Diego Sales de Oliveira (diego.salesdeoliveira@cea.fr)
Alex Grosjean, Guido Ciraolo, Alexis Huart

- **Scientific Background & Objectives**

  - Validate 3D W-migration modelling using SOLEDGE3X+ERO2.0 accounting for realistic wall and magnetic (ripples) geometries
  - Produce datasets for different values of density and Psol
  - Characterize the strength and position of the W-source, the main routes for core-contamination, and the impact of ripples and non-axisymmetric walls in the overall W-dynamics using ERO2.0 simulations
  - Investigate the W-screening efficiency in lower X-point height geometries

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Repeats for shots from C10/9 WEST campaign for lower X-point height and 2MW LHCD/400kA (f. e. 61488) and improve the minimum incident angle for FMP
  - Langmuir probes in the max and min probe locations, RCP, McPherson
  - Development of the higher density and Psol scenarios from the reference scenario



Proposed pulses

Device	# Pulses/Session	# Development
WEST	15	5

#139 : W-migration in lower X-point height geometries in WEST accounting for 3D realistic walls and magnetic geometry for the validation of tokamak boundary simulations

- **Proponents and contact person:**

Diego Sales de Oliveira (diego.salesdeoliveira@cea.fr)
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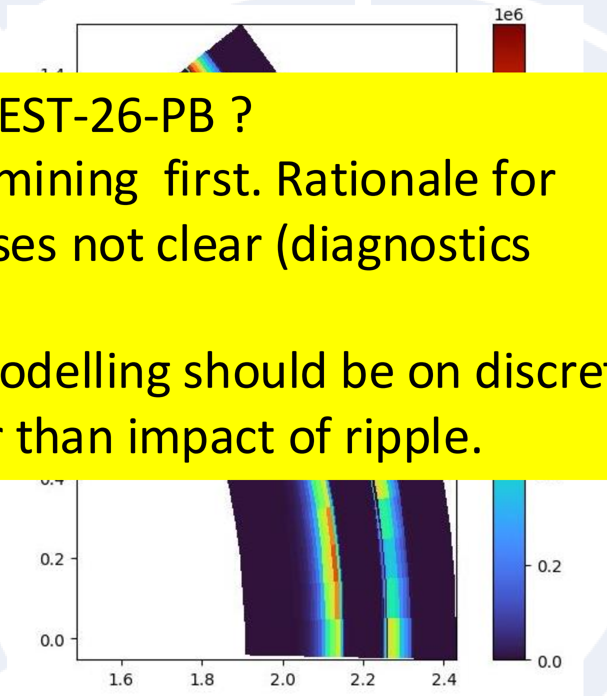


Priority: P1-WEST-26-PB ?
Perform data mining first. Rationale for additional pulses not clear (diagnostics settings ?)
Focus of 3D modelling should be on discrete limiters rather than impact of ripple.

Proposed pulses

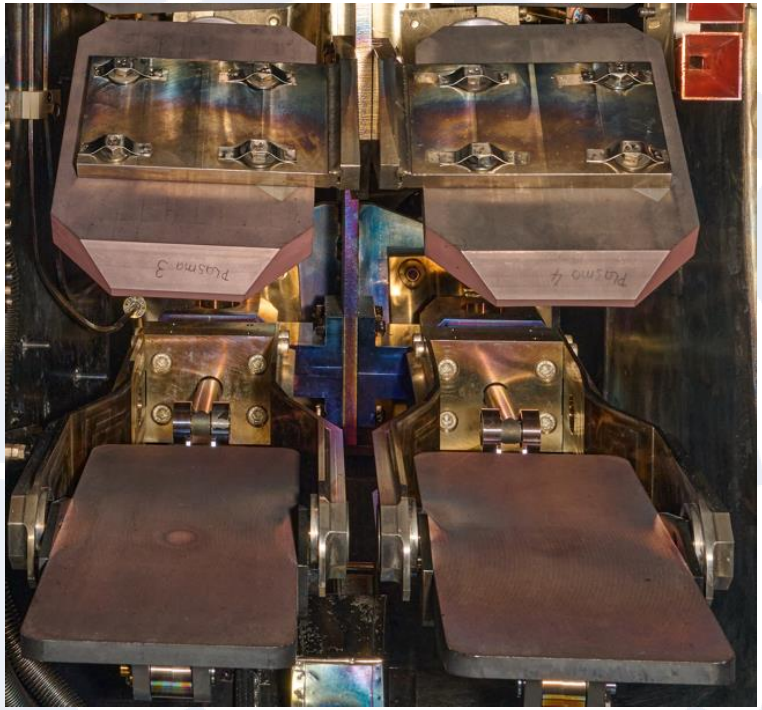
Device	# Pulses/Session	# Development
WEST	15	5

#120 : Effect of second harmonic ECH resonance on arcing risks inside the EC launcher

- **Proponents and contact person:**
  - **Mireille Schneider** (mireille.schneider@iter.org)
  - Alessandro Danisi (alessandro.danisi@iter.org)
  - Melanie Preynas (melanie.preynas@iter.org)
  - Jörg Stober (joerg.stober@ipp.mpg.de)
  - Alberto Loarte (alberto.loarte@iter.org)
  - Tom Wauters (tom.wauters@iter.org)
  - Lena Delpech (lena.delpech@cea.fr)

- **Scientific Background & Objectives**
  - In ITER EC launchers (equatorial and upper), the existence of higher harmonics of EC resonance can pose arcing risks
  - The arcing risk is due to either neutral gas breakdown or secondary electron emission.
  - This issue potentially threatens the correct and continuous operation of the EC launchers.
  - Such arcing risks have materialised in arcing events observed on several devices (e.g. FTU, DIII-D, Tore-Supra).
  - The first objective is to observe the phenomena by modifying the EC launcher layout with stainless elements in the EC second harmonic resonance location.
  - The measurable objectives is to record diagnostic signals or visual evidence of the arcing.
  - In a second campaign, replace the stainless steel elements with surface-treated elements according to identified mitigation strategies.
  - The measurable objectives is to record diagnostic signals or visual evidence of the arcing with the aim to record the effectiveness (or not) of the surface treatment.

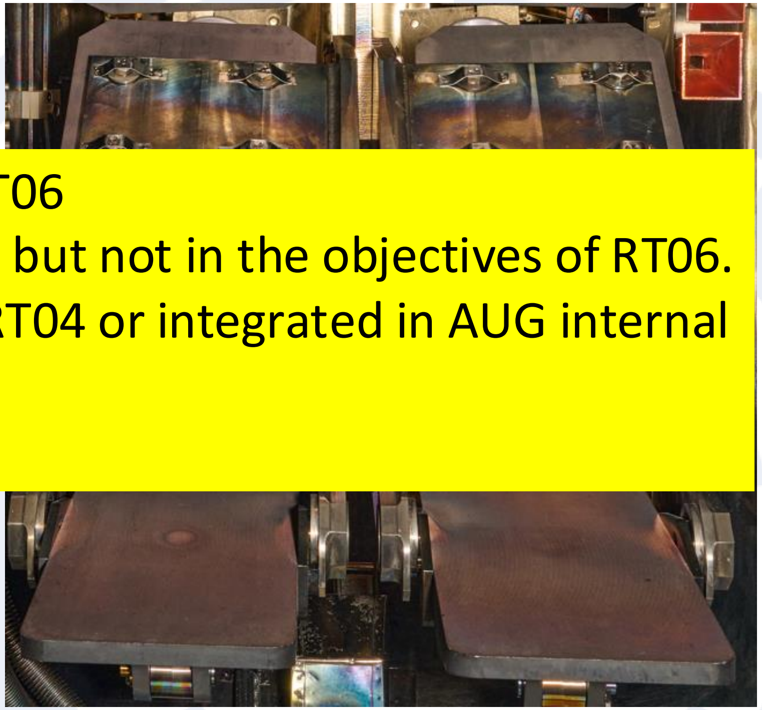
- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Operation with pulses with Gyrotron 2 (Sector 6) at max reliable power with:
    - B = -3.17 T (this fixes the second harmonic region between the stainless steel plates)
    - Plasma Current = 1 MA with 5 MW NBI power
    - Pressure to be safely maximised
    - Density = 8E19 m^{-3} (Ref. 26864), high enough to operate without central EC
    - Steering angles = poloidal 10deg, toroidal 0-25deg (TBD – these values roughly corresponds to 0%-30% X-mode power fraction)
    - 2 ports for diagnostics for arc detection: one with sniffer probe and one with video system. Alternatives for using a optical fibers can be discussed.



Proposed pulses

Device	# Pulses/Session	# Development
AUG	10	0

#120 : Effect of second harmonic ECH resonance on arcing risks inside the EC launcher



Priority: out of scope for RT06
High priority issue for ITER, but not in the objectives of RT06.
Proposed to be shifted to RT04 or integrated in AUG internal programme

Proponents and contact person:

- **Mireille Schneider** (mireille.schneider@iter.org)
- Alessandro Danisi (alessandro.danisi@iter.org)
- Melanie Preynas (melanie.preynas@iter.org)
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  - 2 ports for diagnostics for arc detection: one with sniffer probe and one with video system. Alternatives for using a optical fibers can be discussed.

Proposed pulses

Device	# Pulses/Session	# Development
AUG	10	0

Fuel retention / recovery and vessel conditioning (D4, D5, D7)

#117 : Validation of the modelling of boron powder injection and boron film deposition

➢ Proponents and contact person

S. Ratynskaia srat@kth.se, P. Tolias, S. Brezinsek, K. Krieger, V. Rohde, T. Lunt, D. Matveev, J. Romazanov, M. De Angeli, T. Wauters, R. A. Pitts

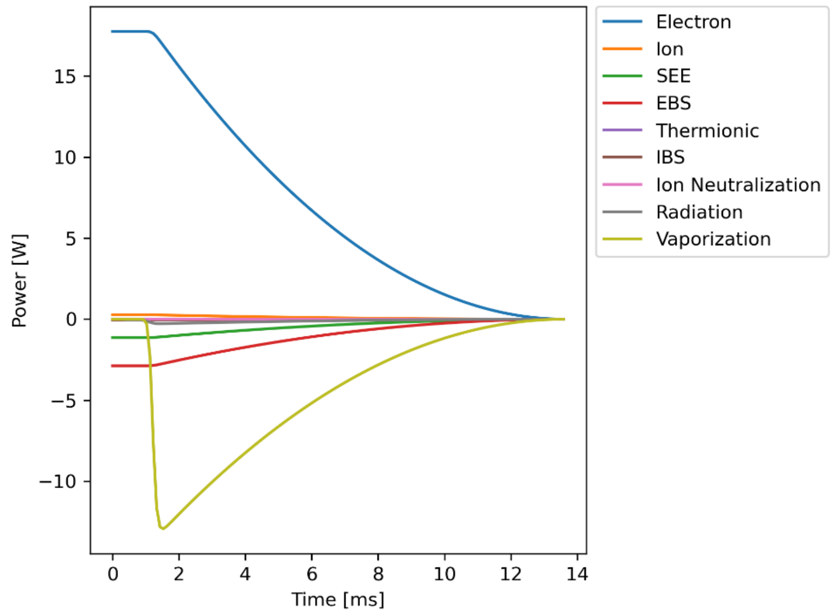
➢ Scientific Background & Objectives

- **Validate** the modelling of boron dust transport and ablation in fusion plasmas with a focus on the impurity source term due to boron dust vaporization.
- **Provide** experimental data for intense boron dust-plasma interaction resulting in dust ablation.
- **Model** boron dust transport and vaporization with MIGRAINe → provide impurities as input to ERO 2.0

➢ Experimental Strategy & Essential diagnostic

- Impurity powder dropper or piezoelectric injector.
- Small and large size monodisperse boron populations to probe different dust plasma collection regimes.
- Record the injected dust trajectories.
- Observe the ablated material and transported impurities with spectroscopic means.
- Install witness plates on the divertor and mid-plane manipulators to measure the boron film deposition.

Validate** the MIGRAINe code and the MIGRAINe + ERO 2.0 workflow for boron – **a material with poorly known surface properties



Names can be deceiving: "dust transport codes" are often less about transport and more about **heating**

MIGRAINe boasts a complete description of microphysical processes & features a reactor-relevant plasma collection model, both critical for accurate heat balance predictions. The MIGRAINe state-of-the-art plasma-surface interaction models were very recently extended to boron.

Device	# Pulses	# Development
AUG	8	1-2 (reference L-mode scenario tbd)

#117 : Validation of the modelling of boron powder injection and boron film deposition

➢ Proponents and contact person

S. Ratynskaia srat@kth.se, P. Tolias, S. Brezinsek, K. Krieger, V. Rohde, T. Lunt, D. Matveev, J. Romazanov, M. De Angeli, T. Wauters, R. A. Pitts

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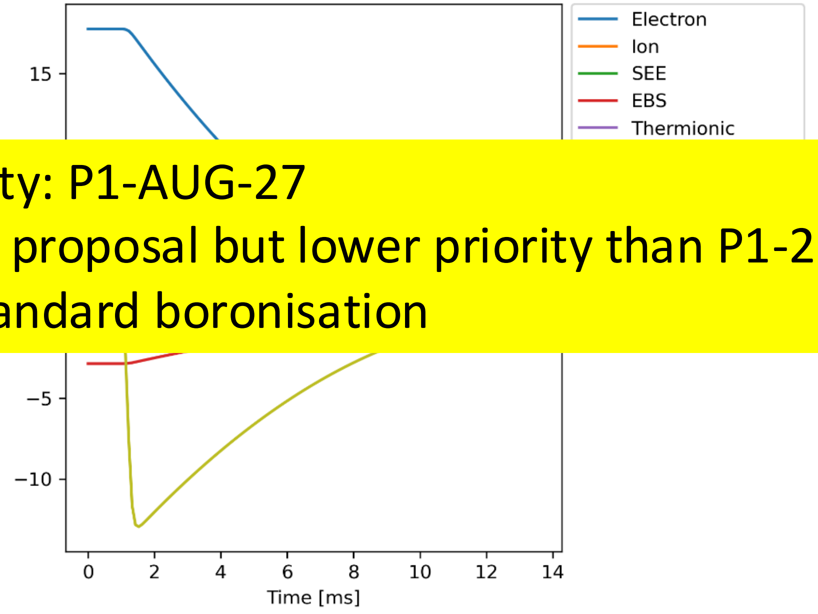

Priority: P1-AUG-27
Good proposal but lower priority than P1-26 on standard boronisation

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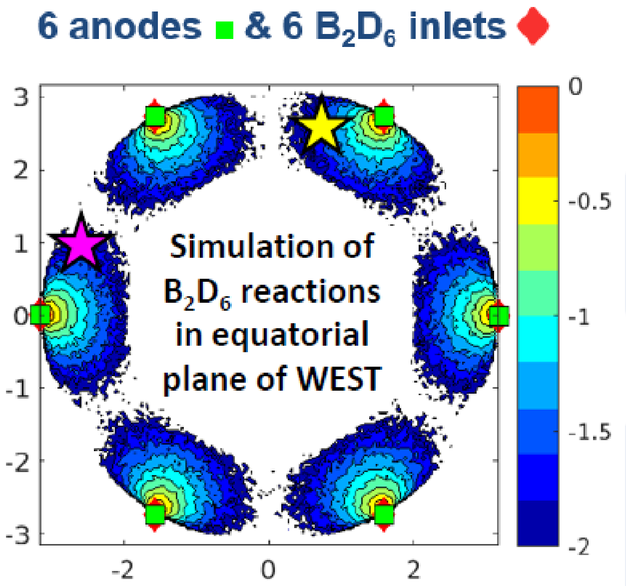
Device	# Pulses	# Development
AUG	8	1-2 (reference L-mode scenario tbd)

#127 : Effect of spatially (non--)uniform boronization on plasma parameters, wall retention and B rich layer properties

- **Proponents and contact person:**
- A. Gallo, M. Diez, E. Geulin, E. Hodille, J. Gaspar, P. Manas, P. Puglia, N. Rivals, J. Denis, T. Wauters, L. Laguardia, G. Gervasini, E. Pawelec
- alberto.gallo@cea.fr

- **Scientific Background & Objectives**
  - Full-W wall in ITER calls for quantitative studies on boronization
  - Standard GDB with mixed W-BN wall => studied in WEST in 2024
  - Non-uniform GDB with full-W wall ==> studied in WEST in 2025
  - **Standard GDB with full-W wall ==> crucial missing dataset (originally planned fall 2025, might shift to 2026)**

- **Experimental Strategy / Constraints / Diagnostics**
  - One day of plasma ops (20 good pulses) far from previous GDB to verify stability of wall conditions and quantify performance
  - Standard boronization with 2 collector probes ☆☆
  - One day of plasma ops (20 good pulses) right after the GDB to asses improvement of condition and monitor degradation



Proposed pulses

Device	# Pulses/Session	# Development
AUG		
MAST-U		
TCV		
WEST	2 op days (40 pulses) + 1 boronization day	

#127 : Effect of spatially (non--)uniform boronization on plasma parameters, wall retention and B rich layer properties

- **Proponents and contact person:**
- A. Gallo, M. Diez, E. Geulin, E. Hodille, J. Gaspar, P. Manas, P. Puglia, N. Rivals, J. Denis, T. Wauters, L. Laguardia, G. Gervasini
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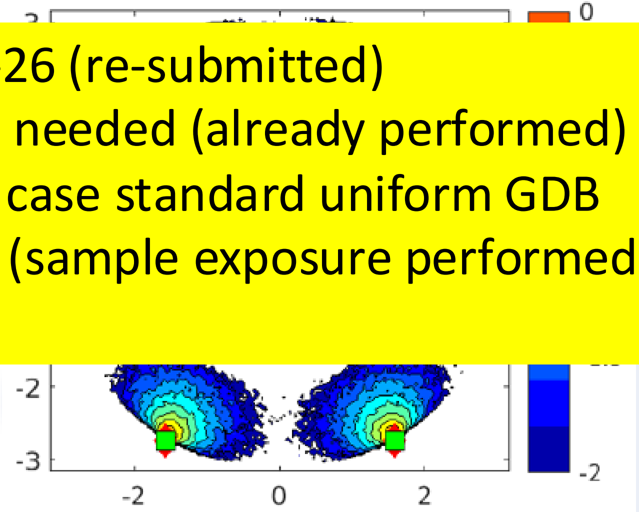
  - One day of plasma ops (20 good pulses) right after the GDB to asses improvement of condition and monitor degradation

6 anodes ■ & 6 B_2D_6 inlets ◆



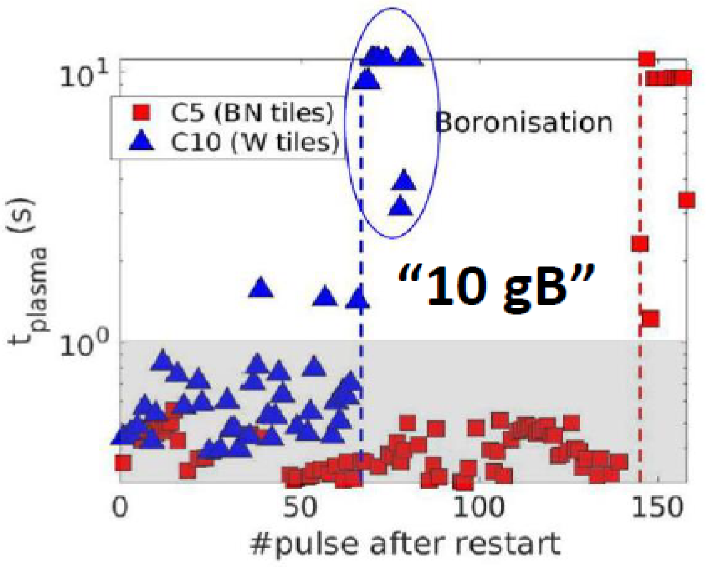
Priority: P1-WEST-26 (re-submitted)
Is pre GDB session needed (already performed) ?
To be cancelled in case standard uniform GDB successful in 2025 (sample exposure performed yesterday)

Proposed pulses

Device	# Pulses/Session	# Development
AUG		
MAST-U		
TCV		
WEST	2 op days (40 pulses) + 1 boronization day	

#128 : Minimum B2D6 quantity to restart WEST operations

- **Proponents and contact person:**
- A. Gallo, M. Diez, E. Geulin, E. Hodille, J. Gaspar, P. Manas, P. Puglia, N. Rivals, J. Denis, T. Wauters, L. Laguardia, G. Gervasini, E. Pawelec
- alberto.gallo@cea.fr



- **Scientific Background & Objectives**
  - Full-W wall in ITER calls for quantitative studies on boronization
  - Boronization necessary to restart WEST operations efficiently
  - B_2D_6 expensive, T retention in B, need to minimize consumption
  - WEST standard procedure utilizes ~10 g of B, probably overkill

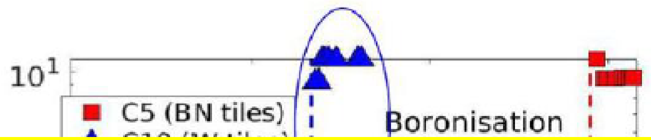
- **Experimental Strategy / Constraints / Diagnostics**
  - After vent boronize with (for example) 1gB
  - Try to restart ops ==> Success? Done
    ==> Failure? Boronize again (1 gB or 2 gB)
  - Try to restart ops ==> Success? Done
    ==> Failure? Boronize again (1 gB or 2 gB)
  - ...

Proposed pulses

Device	# Pulses/Session	# Development
AUG		
MAST-U		
TCV		
WEST	4 ops days + 4 GDB days	

#128 : Minimum B2D6 quantity to restart WEST operations

- **Proponents and contact person:**
- A. Gallo, M. Diez, E. Geulin, E. Hodille, J. Gaspar, P. Manas, P. Puglia, N. Rivals, J. Denis, T. Wauters, L. Laguardia, G. Gervasini, E. Pa
- alberto.gallo@cea.fr



Priority: P1-WEST-26
Important topic for ITER where B needs to be minimized to avoid fuel retention.
More analysis needed (B thickness estimate etc) to define minimum amount of B to be tried.

- **Scientific Background & Objectives**
  - Full-W wall in ITER calls for quantitative studies on boroniz
  - Boronization necessary to restart WEST operations efficier
  - B_2D_6 expensive, T retention in B, need to minimize consum
  - WEST standard procedure utilizes ~10 g of B, probably overkill

- **Experimental Strategy / Constraints / Diagnostics**
  - After vent boronize with (for example) 1gB
  - Try to restart ops ==> Success? Done
    ==> Failure? Boronize again (1 gB or 2 gB)
  - Try to restart ops ==> Success? Done
    ==> Failure? Boronize again (1 gB or 2 gB)
  - ...

Proposed pulses

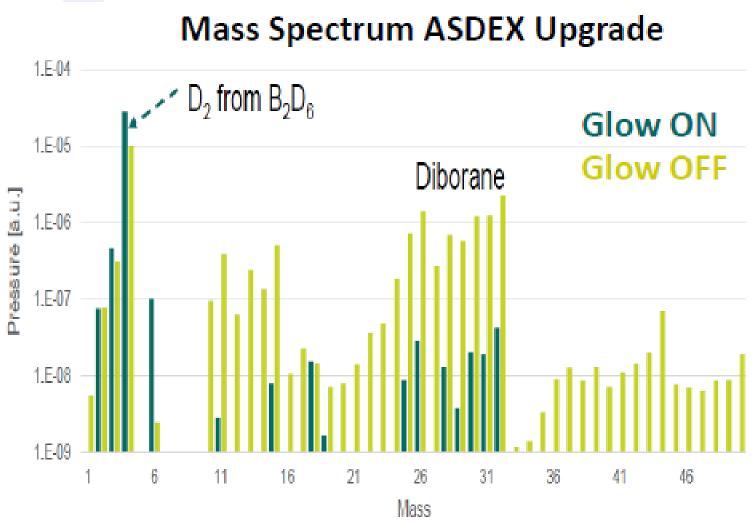
Device	# Pulses/Session	# Development
AUG		
MAST-U		
TCV		
WEST	4 ops days + 4 GDB days	

#129 : Boronization with and without glow discharge in WEST

- **Proponents and contact person:**
- A. Gallo, M. Diez, E. Geulin, E. Hodille, J. Gaspar, P. Manas, P. Puglia, N. Rivals, J. Denis, T. Wauters, L. Laguardia, G. Gervasini, E. Pawelec
- alberto.gallo@cea.fr

- **Scientific Background & Objectives**
  - Full-W wall in ITER calls for quantitative studies on boronization
  - B_2D_6 expensive, need to maximize cracking efficiency
  - AUG results on GDB at room temperature [Rohde PMFC 2025]
  - Depends on glow parameters but also wall temperature

- **Experimental Strategy / Constraints / Diagnostics**
  - Identify B_2D_6 fragments in WEST mass spectra
  - Boronization without glow at low T_{wall}
  - Boronization with glow at low T_{wall}
  - Boronization without glow at high T_{wall}
  - Boronization with glow at high T_{wall}



Proposed pulses

Device	# Pulses/Session	# Development
AUG		
MAST-U		
TCV		
WEST	4 boronization days	

#129 : Boronization with and without glow discharge in WEST

- **Proponents and contact person:**
- A. Gallo, M. Diez, E. Geulin, E. Hodille, J. Gaspar
  N. Rivals, J. Denis, T. Wauters, L. Laguardia, G. G
- alberto.gallo@cea.fr

- **Scientific Background & Objectives**
  - Full-W wall in ITER calls for quantitative stuc
  - B_2D_6 expensive, need to maximize cracking e
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- **Experimental Strategy / Constraints / Diagnostics**
  - Identify B_2D_6 fragments in WEST mass spectra
  - Boronization without glow at low T_{wall}
  - Boronization with glow at low T_{wall}
  - Boronization without glow at high T_{wall}
  - Boronization with glow at high T_{wall}

Priority: P2-WEST
Feasibility to be assessed (boro w/o GDC and/or ICWC)
Need for reference discharges to qualify boronisation efficiency afterwards not included.
To be combined with alternative to standard GDB #124.
Need to streamline on most urgent item (Twall vs ICWC boronisation vs pure boronisation) to be discussed with IO

Mass

Proposed pulses

Device	# Pulses/Session	# Development
AUG		
MAST-U		
TCV		
WEST	4 boronization days	

#124 : Developmentof ICWC assisted boronization

In collaboration with ITER PWI group

- **Proponents and contact person:**

  E. Lerche, T. Wauters, J. Hillairet, L. Colas, P. Dumortier, A. Gallo, E. Guelin, Ph. Moreau, V. Lamaison, V. Bobkov, R. Ochoukov, R. Bilato …

- **Scientific Background & Objectives**
  - ICWC is very efficient for implanting ions in the first wall
  - ITER is considering the possibility of using IC plasmas to deposit thin Boron layers in the first wall without the need of reducing the magnetic field; This could replace (or complement) the general Boronization procedure which requires the magnetic field to be lowered at every time
  - Objectives:
    - Develop a procedure for ICWC boronization in WEST and AUG (EAST ongoing)
    - Demonstrate and characterize the ICWC boronization properties (homogeneity, layer ‘thickness’ (indirect), etc …)
    - Validate theoretical predictions for ITER

- **Exp. Strategy/Machine Constraints and diagnostics**
  - ICWC scenario well developed in AUG and in WEST.
  - Boronization standard in AUG and WEST
  - Need to develop a procedure for safe ICWC + boronization operation (offline work on safety and operations)
  - Needs one or two sessions for development
  - The scientific session will focus on the boronization efficiency as function of the ICWC plasma properties, to be tested with normal (monitoring) discharges after the ICWC boronization session
  - Main diagnostics used for ICWC experiments + safety measures for Boronization

Important Note:
Before this experiment can go ahead, we need the approval of the local machine operator and safety teams. Discussions are ongoing.

Proposed pulses

Device	# Pulses/Session	# Development
AUG	1 Session	1 session + detailed off-line preparation (safety issues)
WEST	1 Session	1 session + detailed off-line preparation (safety issues)

#124 : Developmentof ICWC assisted boronization

In collaboration with ITER PWI group

- **Proponents and contact person:**

E. Lerche, T. Wauters, J. Hillairet, L. Colas, P. Dumortier, A. Gallo, E. Guelin, Ph. Moreau, V. Lamaison, V. Bobkov, R. Ochoukov, R. Bilato …

- **Scientific Background & Objectives**
  - ICWC is very efficient for implanting ions in the first wall
  - ITER is considering the possibility of using IC plasmas to deposit thin B layers in the first wall without the need of reducing the magnetic field could replace (or complement) the general Boronization procedure w requires the magnetic field to be lowered at every time
  - Objectives:
  - Develop a procedure for ICWC boronization in WEST and AUG (EAST ongoing)
  - Demonstrate and characterize the ICWC boronization properties (homogeneity, layer 'thickness' (indirect), etc …)
  - Validate theoretical predictions for ITER

Priority: P1-AUG-26, P1-WEST-26
Innovative, multi machine, great gain for ITER if boronisation can be perfomed w/o lowering B field. To be discussed in conjunction with proposal # 129.
Technical feasibility to be confirmed

- **Exp. Strategy/Machine Constraints and diagnostics**
  - ICWC scenario well developed in AUG and in WEST.
  - Boronization standard in AUG and WEST
  - Need to develop a procedure for safe ICWC + boronization operation (offline work on safety and operations)
  - Needs one or two sessions for development
  - The scientific session will focus on the boronization efficiency as function of the ICWC plasma properties, to be tested with normal (monitoring) discharges after the ICWC boronization session
  - Main diagnostics used for ICWC experiments + safety measures for Boronization

Proposed pulses

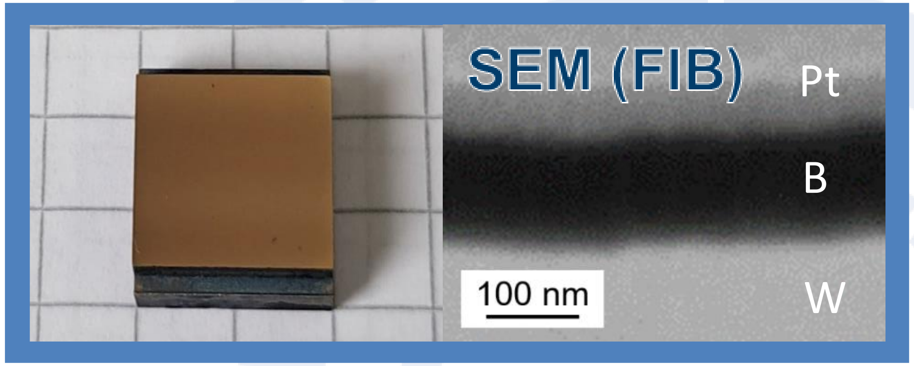
Device	# Pulses/Session	# Development
AUG	1 Session	1 session + detailed off-line preparation (safety issues)
WEST	1 Session	1 session + detailed off-line preparation (safety issues)

#140 : Preparation of B reference samples

- **Proponents and contact person:**
  T.dittmar@fz-juelich.de
  An.houben@fz-juelich.de

- **Scientific Background & Objectives**
  Investigation of B coatings fabricated in different fusion devices:
  - Comparison of composition of B layer
  - Study of the mechanism of the impurity gettering of the boron layer during boronization
  - Comparison with laboratory samples
  - Identical tungsten substrate samples

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Pre-characterized samples exposed on manipulator systems during boronization
  - samples must be retrieved before normal plasma Operation and should be carried in air/humidity tight containers.



Proposed pulses

Device	# Pulses/Session	# Development
AUG	During boronization	
MAST-U		
TCV		
WEST	During boronization	

#140 : Preparation of B reference samples

- **Proponents and contact person:**
  T.dittmar@fz-juelich.de
  An.houben@fz-juelich.de

- **Scientific Background & Objectives**
  Investigation of B coatings fabricated in different fusion devices:
  - Comparison of composition of B layer
  - Study of the mechanism of the impurity gettering of the boron layer during boronization
  - Comparison with laboratory samples
  - Identical tungsten substrate samples

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Pre-characterized samples exposed on manipulator systems during boronization
  - samples must be retrieved before normal plasma Operation and should be carried in air/humidity tight containers.

Priority: P1-AUG-26-PB and P1-WEST-26-PB
Would provide tokamak relevant B layers to be studied in WP PWIE
Readiness of samples + compatibility with AUG/WEST exposure devices to be confirmed
Sample management challenging (no air exposure desirable)

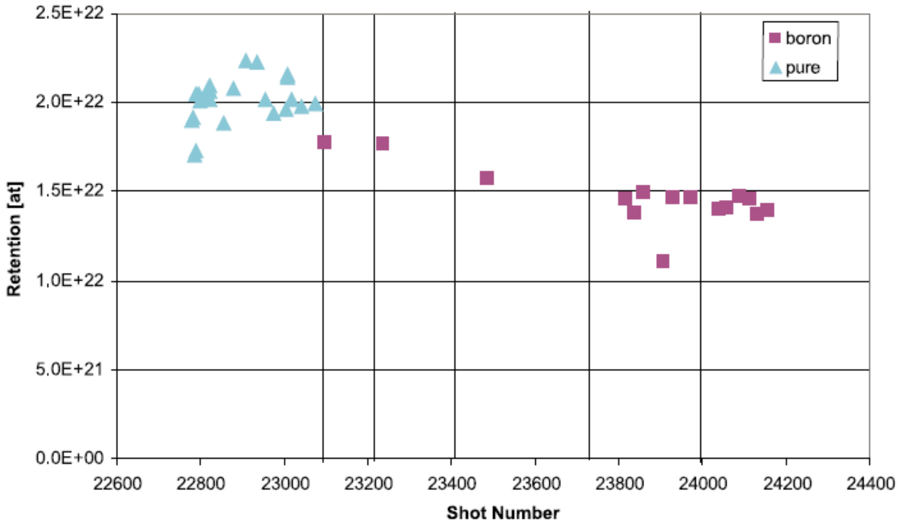
Proposed pulses

Device	# Pulses/Session	# Development
AUG	During boronization	
MAST-U		
TCV		
WEST	During boronization	

#125 : Particle balance in AUG as a measure of global D retention in pulses following fresh boronisation

- **Proponents and contact person**
  D. Matveev, S. Brezinsek, V. Rohde, T. Wauters, …
- **Scientific Background & Objectives**
  - Fuel retention in as-deposited and re-deposited boron layers is a potential safety issue in full W ITER. Predictive estimates require validation in existing full W devices. Earlier analysis [1] mostly focused on pulses without boronisation.
  - Apply global particle balance analysis method to follow the evolution of in-vessel fuel retention in-pulse and in short-term as a function of plasma time after boronization.
- **Experimental Strategy & Essential Diagnostic**
  - Re-calibrate all relevant neutral gas diagnostics (pressure gauges, pumping speeds, RGAs, …)
  - Execute reference pulses prior and repetitively after boronization to follow the evolution of in-vessel retention
  - Essential diagnostics:
    - Pressure gauges
    - Optical Penning
    - RGAs
    - Plasma spectroscopy
    - Core plasma density (LIDAR/HRTS/…)

[1] V. Rohde et al., JNM 390–391 (2009) 474
doi:10.1016/j.jnucmat.2009.01.047



Wall retention needed to reach steady-state conditions
Cyan triangles - data for non-boronized wall
Magenta squares - after boronizations (vertical lines)

[2] V. Rohde et al., PPPCF 51 (2009) 124033
doi:10.1088/0741-3335/51/12/124033

Device	# Pulses	# Development
AUG	>10+7	Reference pulse to be identified from previous studies and in connection to relevant proposals, such as “Boronization efficiency”

#125 : Particle balance in AUG as a measure of global D retention in pulses following fresh boronisation

- **Proponents and contact person**
  D. Matveev, S. Brezinsek, V. Rohde, T. Wauters, …
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    - Optical Penning
    - RGAs
    - Plasma spectroscopy
    - Core plasma density (LIDAR/HRTS/…)

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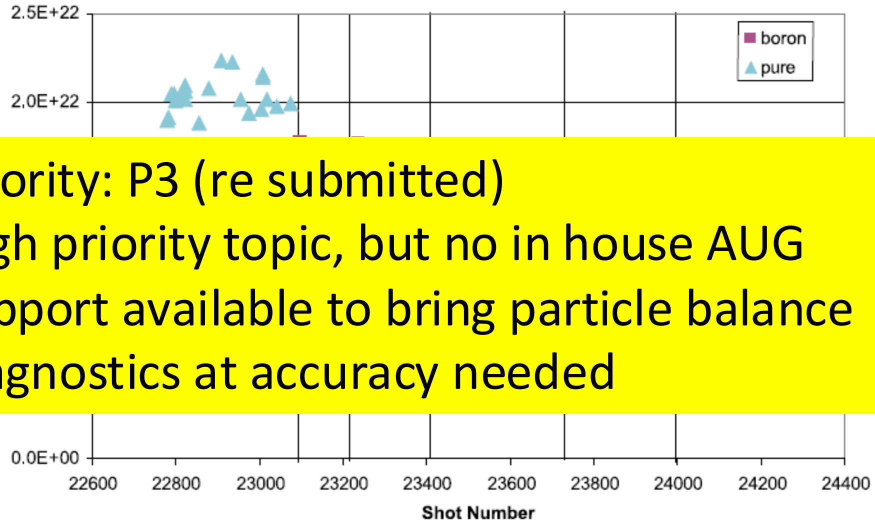


Priority: P3 (re submitted)
High priority topic, but no in house AUG support available to bring particle balance diagnostics at accuracy needed

Wall retention needed to reach steady-state conditions
Cyan triangles - data for non-boronized wall
Magenta squares - after boronizations (vertical lines)

[2] V. Rohde et al., PPPCF 51 (2009) 124033
doi:10.1088/0741-3335/51/12/124033

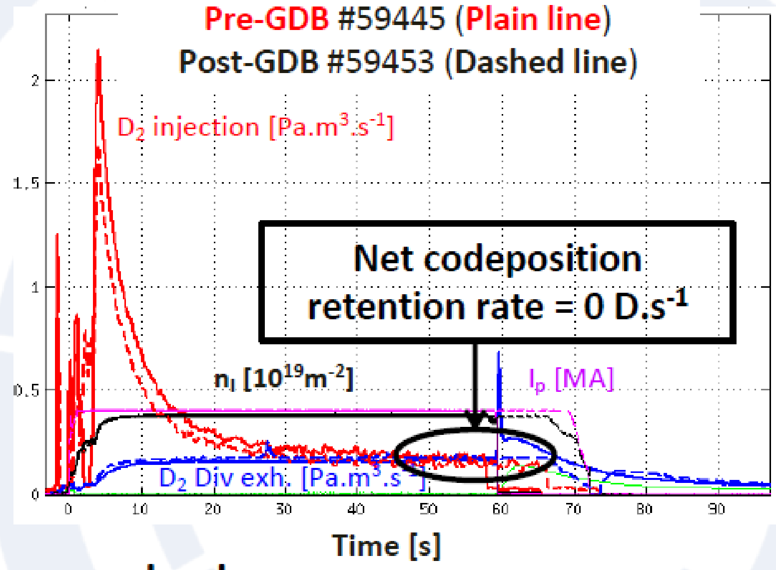
Device	# Pulses	# Development
AUG	>10+7	Reference pulse to be identified from previous studies and in connection to relevant proposals, such as "Boronization efficiency"

#126 : Estimation of the H/D retention by codeposition in boronized fusion devices through D-to-H-to-D changeover in WEST

- **Proponents and contact person:**
- J. Denis, A. Gallo, R. Bisson, M. Diez, E. Hodille, J. Gaspar, G. Gervasini, E. Geulin, L. Laguardia, P. Manas, D. Mazur, E. Pawelec, P. Puglia, N. Rivals, R. Stamm, S. Vartanian, T. Wauters
- julien.denis@univ-amu.fr

- **Scientific Background & Objectives**
  - Full-W wall in ITER calls for quantitative studies on Glow Discharge Boronization (GDB)
  - Minimum B mass needed to operate while respecting T budget?
  - B_2D_6 GDB resulting in zero net D retention rate by codeposition during subsequent D discharges => D plasmas following GDB do not provide full insight into the overall retention of hydrogen isotopes via gas balance.

- **Experimental Strategy / Constraints / Diagnostics**
  - Changeover D-to-H before GDB to estimate pre-GDB retention by codeposition.
  - Changeover H-to-D to recover initial wall state.
  - Uniform GDB in WEST, diagnosed with RGAs to estimate deposited B and D quantity.
  - H discharges after GDB, followed by H-to-D changeover, to estimate post-GDB retention by codeposition.
  - Dedicated pulses to compare plasma before/after GDB, without midplane and/or divertor pumping to improve the gas balance accuracy.
  - Visible spectroscopy to estimate H/D ratio and BH/BD ratio.
  - Modeling of changeover with SolEdge-EIRENE boundary plasma model and MHIMS hydrogen retention model.



Proposed pulses

Device	# Pulses/Session	# Development
AUG		
MAST-U		
TCV		
WEST	4 op days (80 pulses) + 1 boronization day	4 pulses

#126 : Estimation of the H/D retention by codeposition in boronized fusion devices through D-to-H-to-D changeover in WEST

- **Proponents and contact person:**
- J. Denis, A. Gallo, R. Bisson, M. Diez, E. Hodille, J. Gaspar, G. Gervasini, E. Geulin, L. Laguardia, P. Manas, D. Mazur, E. Pawelec, P. Puglia, N. Ri… T. Wauters
- julien.denis@univ-amu.fr

- **Scientific Background & Objectives**
  - Full-W wall in ITER calls for quantitative studies on G… (GDB)
  - Minimum B mass needed to operate while respecting T…
  - B_2D_6 GDB resulting in zero net D retention rate by codep… discharges => D plasmas following GDB do not provide… retention of hydrogen isotopes via gas balance.

- **Experimental Strategy / Constraints / Diagnostics**
  - Changeover D-to-H before GDB to estimate pre-GDB ret…
  - Changeover H-to-D to recover initial wall state.
  - Uniform GDB in WEST, diagnosed with RGAs to estimate deposited B and D quantity.
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  - Dedicated pulses to compare plasma before/after GDB, without midplane and/or divertor pumping to improve the gas balance accuracy.
  - Visible spectroscopy to estimate H/D ratio and BH/BD ratio.
  - Modeling of changeover with SolEdge-EIRENE boundary plasma model and MHIMS hydrogen retention model.

Pre-GDB #59445 (Plain line)

Priority: P1-WEST-27
Interesting conceptual idea but need to refine numbers at stake (codep with B compared to injected/exhaust flux).
To be combined with post mortem at the end of a campaign (but post mortem difficult with H).
Previous changeover in WEST to be looked at in more details from particle balance point of view.
Priority to be re assessed once we have more analysis.

Proposed pulses

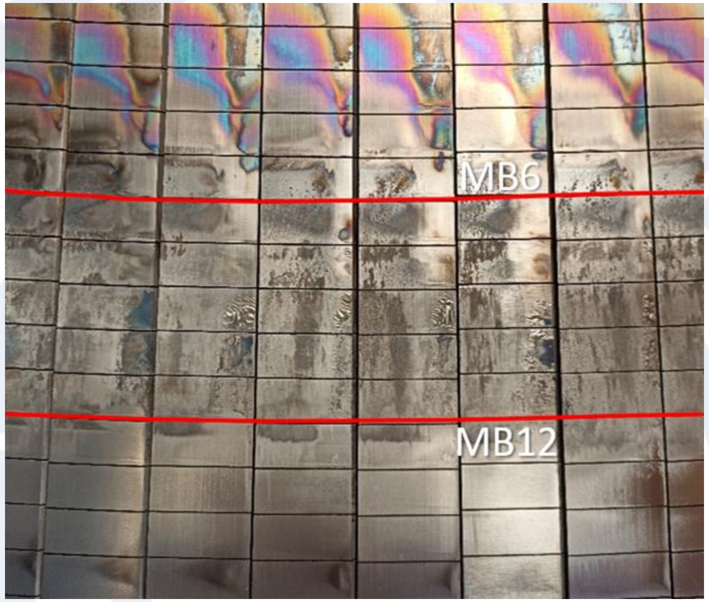
Device	# Pulses/Session	# Development
AUG		
MAST-U		
TCV		
WEST	4 op days (80 pulses) + 1 boronization day	4 pulses

#122 : Study about the outgassing of the deposit layer

- **Proponents and contact person:**

Jonathan.gerardin@cea.fr, Yann.corre@cea.fr, Eleonore.geulin@cea.fr, agrosjea@utk.edu, Etienne.hodille@cea.fr, Jonathan.gaspar@univ-amu.fr, ewap@uni.opole.pl,

- **Scientific Background & Objectives**
  - During campaign, a deposit layer appears on the inner side of the lower divertor, from MB7-11,
  - The thick deposit contains light impurities and probably also trapped fuel. Heating the deposit to high temperature lead to outgassing from the deposit (twice more light impurities released, from C10 experiment) → improve the conditioning for next pulses
  - Objectives :
    - Study the light impurities and molecular deuterium particle flux when the plasma is on the deposit
    - Compare the impurities extracted at beginning and end of session
    - Determine how many pulses are needed to outgas the deposit from light impurities.
    - Follow up from campaign to campaign could be done to evaluate the content of the deposit.
- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - LSN, FXP (100mm-120m) LH 4MW, 400kA → FISP (scenarios already exists)
  - Use visible spectroscopy and LP probes to measure particle flux of light impurities
  - Use RGA to detect the light impurities extracted
  - Estimate the particle balance evolution from pulse to pulse.
  - 1 session to study the outgassing, and some pulses on different campaign to follow from campaign to campaign.
  - Diagnostic needed :
    - Visible and EUV spectroscopy – RGA to monitor impurities extracted from the deposit.
    - LP needed to estimate flux of impurities.
    - Optional : TC-FBG for heat flux. IR VHR on Q3B PFU19-20 MB11 to follow some modification of deposit pattern (1 PFU not cleaned by laser after C11).



Proposed pulses

Device	# Pulses/Session	# Development
AUG	0	0
MAST-U	0	0
TCV	0	0
WEST	30	0

#122 : Study about the outgassing of the deposit layer

- **Proponents and contact person:**

Jonathan.gerardin@cea.fr, Yann.corre@cea.fr, Eleonore.geulin@cea.fr, agrosjea@utk.edu, Etienne.hodille@cea.fr, Jonathan.gaspar@univ-amu.fr, ewap@uni.opole.pl,

- **Scientific Background & Objectives**
  - During campaign, a deposit layer appears on the inner side of MB7-11,
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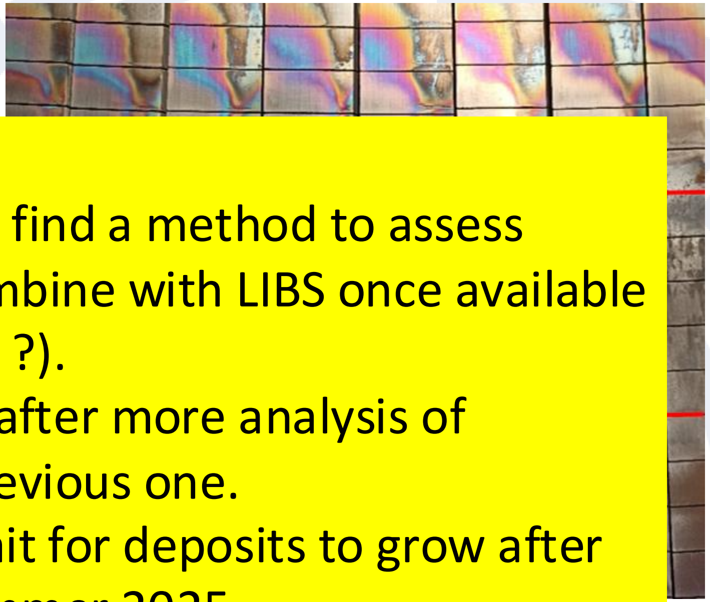


Priority: P2-WEST
Interesting but need to find a method to assess cleaning efficiency (combine with LIBS once available at end of the campaign ?).
Proposal to be refined after more analysis of spectroscopy etc on previous one.
In any case, need to wait for deposits to grow after divertor cleaning in summer 2025 …

Proposed pulses

Device	# Pulses/Session	# Development
AUG	0	0
MAST-U	0	0
TCV	0	0
WEST	30	0

#123 : Impact of ICWC on plasma operation

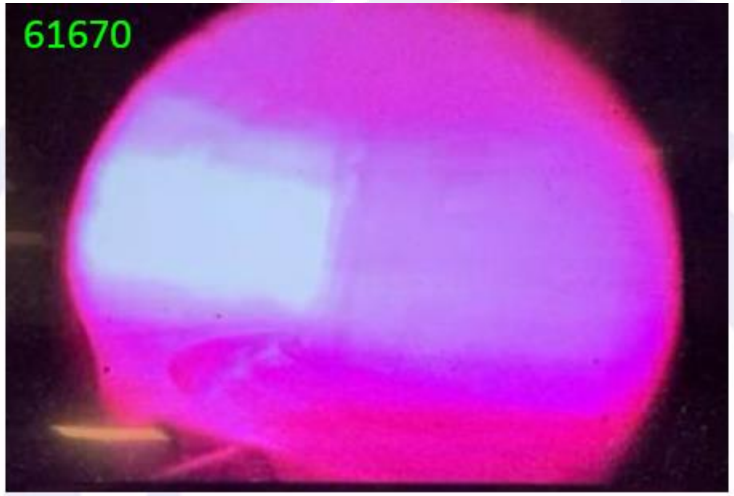
In collaboration with ITER PWI group

- **Proponents and contact person:**

E. Lerche, J. Hillairet, Y. Corre, T. Wauters, L. Colas, P. Dumortier, E. Guelin, V. Bobkov, R. Ochoukov, R. Bilato, ...

- **Scientific Background & Objectives**
  - Ion-cyclotron wall conditioning (ICWC) was successfully developed for wall conditioning and rapid wall isotope exchange in JET, AUG and WEST but a detailed assessment of the post-ICWC plasma properties was never done
  - ITER foresees ICWC for wall conditioning from day 1 so understanding the impact of ICWC on the subsequent plasma performance is key
  - Objectives:
  - Quantify the impact of ICWC in the post-ICWC plasma properties (breakdown, current ramp-up, flat-top, etc...) in different devices; Feed ITER models and extrapolate for ITER SRO phase.
  - Optimize the pre-pulse ICWC procedure (duty-cycle, pressure, pumping-time, etc.) for best plasma performance after a ICWC sequence; Likely different for each machine but helps understanding the optimization path for ITER

- **Exp. Strategy/Machine Constraints and diagnostics**
  - ICWC scenario well developed in AUG and in WEST.
  - Use a well diagnosed reference plasma discharge (monitoring pulse) and intercalate it with ICWC shots with different duty-cycles, waiting times (pumping) and pressure levels; Lokk at the breakdown, ramp-up and flat-top properties of the subsequent plasmas.
  - Main diagnostics for plasma performance used in monitoring pulse and in particular good PWI coverage (edge spectroscopy, divertor diagnostics, etc ...)



Example of ICWC discharge in WEST

Proposed pulses

Device	# Pulses/Session	# Development
AUG	2 Sessions (2026)	Scenario is ready
WEST	2 Sessions (2026)	Scenario is ready

#123 : Impact of ICWC on plasma operation

In collaboration with ITER PWI group

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  E. Lerche, J. Hillairet, Y. Corre, T. Wauters, L. Colas, P. Dumortier, E. Guelin, V. Bobkov, R. Ochoukov, R. Bilato, ...

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  - Use a well diagnosed reference plasma discharge (monitoring pulse) and intercalate it with ICWC shots with different duty-cycles, waiting times (pumping) and pressure levels; Lokk at the breakdown, ramp-up and flat-top properties of the subsequent plasmas.
  - Main diagnostics for plasma performance used in monitoring pulse and in particular good PWI coverage (edge spectroscopy, divertor diagnostics, etc ...)

Priority: P2-AUG, P2-WEST
Interesting proposal but criteria to analyze benefit of ICWC on subsequent plasma ops would be useful.
Propose to focus on analysis of previous data in 2026 (data mining on plasma operation following ICWC sessions) then priority could be re assessed for 2027

Proposed pulses

Device	# Pulses/Session	# Development
AUG	2 Sessions (2026)	Scenario is ready
WEST	2 Sessions (2026)	Scenario is ready

#137 : ICWC operation with TWA

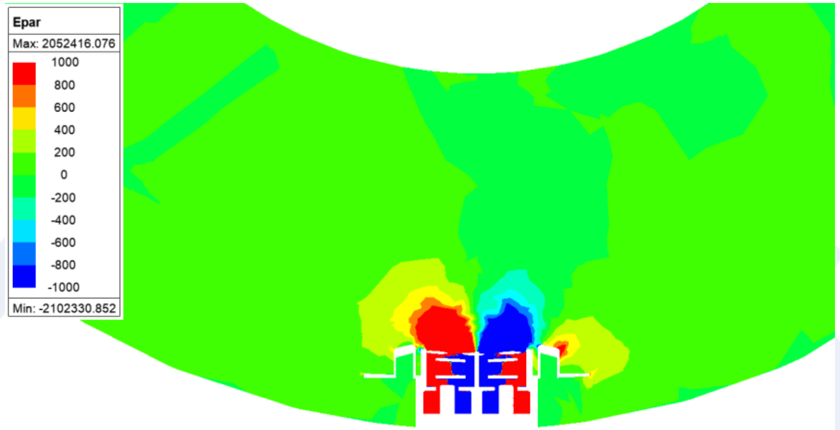
- **Proponents and contact person:**

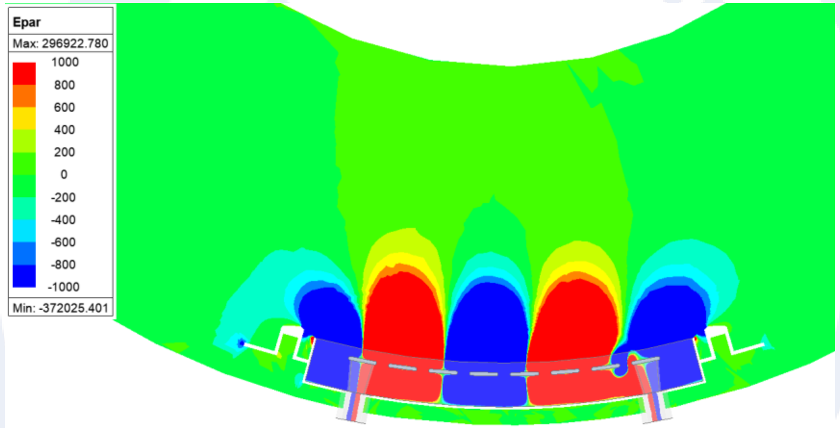
R. Ragona, E. Lerche, V. Maquet, J. Hillairet, et al

- **Scientific Background & Objectives**
  - ITER foresees Ion-cyclotron wall conditioning (ICWC) from day 1 so understanding the impact of ICWC on the subsequent plasma performance is key
  - ICWC successfully developed in JET, AUG and WEST
  - Detailed assessment of the post-ICWC plasma properties expected in 2026
  - New WEST IC launchers (Travelling Wave Array) will be ready for operation in 2027
  - New features that could positively impact ICWC (larger area, freq. modulation, no FS, …)
  - Builds on top of 2026 proposal "*Impact of ICWC on plasma operation*"

  Objectives
  - Quantify the impact on post-ICWC plasma properties (breakdown, Ip ramp-up, flat-top, …)
  - Contribute to ITER models database and to the extrapolation for ITER SRO phase.
  - Consolidate the pre-pulse ICWC procedure (launcher configuration, duty-cycle, pressure, pumping-time, etc.) for best pulse performance.
  - Document the effect of area, freq. modulation and launcher phasing on plasma production. (Input for breakdown and PWI models)

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Repeat scenario developed for WEST
    - Well diagnosed monitoring pulses interleaved with ICWC pulse trains
  - Explore new parameter space
    - Frequency modulation, launcher phasing
    - Find optimal power level and timings
  - Main diagnostics for plasma performance used in monitoring pulse
    - Good PWI coverage (edge spectroscopy, divertor diagnostics, …)





Proposed pulses

Device	# Pulses/Session	# Development
AUG		
MAST-U		
TCV		
WEST	1 session (2027)	

#137 : ICWC operation with TWA

- **Proponents and contact person:**

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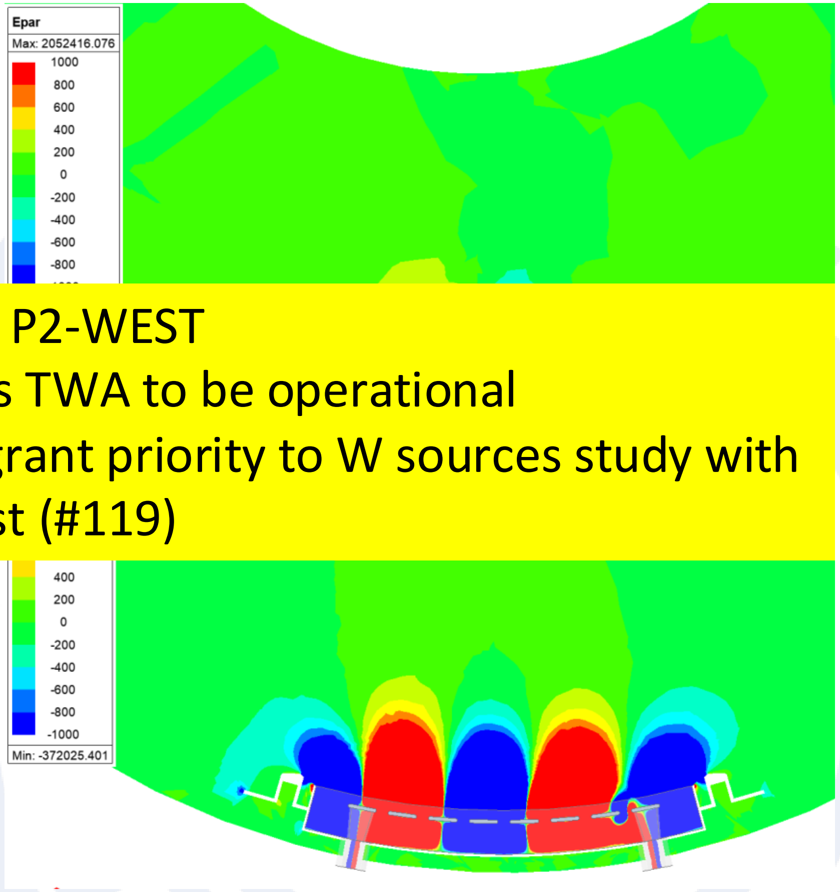

Priority: P2-WEST
Requires TWA to be operational
Would grant priority to W sources study with TWA first (#119)

Proposed pulses

Device	# Pulses/Session	# Development
AUG		
MAST-U		
TCV		
WEST	1 session (2027)	

High priority items to be continued from JET

Fuel retention / recovery

- Further analysis of overall gas balance in DTE3 (+DTE2) (in particular once T accountancy completed, planned in spring 2026)
- Modelling of fuel retention during DTE3 / fuel recovery post DTE3
- Further analysis of LID QMS data (qualitative → quantitative data), in particular evolution during DTE3 clean up
- Comparison of LIBS s LID QMS data for consistency (with PWIE)

(Much) longer term : consistency of gas balance / laser diags measurements / sample post mortem analysis (PWIE)

Material migration

- Further analysis and modelling of W prompt redeposition experiment
- Completion of Be erosion studies + publication : still pending

He campaign

- Further analysis / modelling of the (no) W fuzz formation (more insight from visual inspection once tiles removed ?)

NB : data analysis from previous campaigns under RT11

RT06 analysis and modelling needs (non exhaustive)

PFC evolution / damage

- Heat loads, power balance : thermal diagnostics (IR, TC/FBG, calorimetry, LP ...)
- Field line tracing codes, melting and RE modelling, material modelling (crack formation and propagation)

Material migration

- W sources : visible spectroscopy, bolometry
- Plasma background (SOLEDGE, SOLPS wide grid ...), material migration modelling (ERO, Walldyn ...)

Fuel retention

- Gas balance : barometry, RGA + laser based diagnostics
- Fuel retention / removal modelling (MIMHS ...)
- Conditioning modelling (boronisation, ICWC ...)

Strong links with WP PWIE

In summary …

Overview of RT06 proposals assessment

No	Proposal title	Main proponents	Priority
114	Multi-scale melt dynamics across PFC gaps	K. Krieger	P1-AUG-26
115	Thermomechanical resilience of tungsten heavy alloys at high temperatures	K. Krieger	P1-AUG-26
116	W PFC damage induced by runaway electron incidence	S. Ratynskaia	P1-:AUG-26, P1-WEST-26
134	Exposure of pre-damaged INTERFACE components	A. Durif	P2-WEST
135	Exposure of pre-damaged divertor components (pred#2 & #3)	A. Durif	P1-26-WEST
118	Study of accelerated material damage under a high fluence of helium in WEST	C.Guillemaut	P2-WEST
136	Characterization of the heat load on castellated PFC: optical hot spot, toroidal gap and far SOL power width in WEST L-mode plasma	Y. Corre	P1-WEST-27
121	Calorimetry power balance and ripple effect modulation	J. Gerardin	P1-WEST-27
131	Low-Density ICRF + XPR Mitigation: Scenario development & Trade-off Study	G. Urbanczyk	P2-WEST
132	Low-Density ICRF: Electron Heating & Impurity Transport Validation	G. Urbanczyk	P2-AUG, P2-WEST
119	Comparing W production and core plasma contamination by 2x2 strap Ion Cyclotron Antenna and Travelling Wave Array	L. Colas	P1-WEST-27
130	TWA poloidal phase scan for impurity minimization in WEST	V. Maquet	Merge with #119
133	LH Power Loss Characterization at high coupling with TWA	V. Maquet	P3-WEST
138	Studying Ti/Te ratio and Ti decay length	J. Kovačič	P1-WEST-26
139	W-migration in lower X-point height geometries in WEST accounting for 3D realistic walls and magnetic geometry for the validation of tokamak boundary simulations	D. Sales de Oliveira	P1-WEST-26-PB
120	Effect of second harmonic ECH resonance on arcing risks inside the EC launcher	M. Schneider	Shifted to RT04
117	Validation of the modelling of boron powder injection and boron film deposition	S. Ratynskaia	P1-AUG-27
127	Effect of spatially (non-)uniform boronization on plasma parameters, wall retention and B-rich layer properties	A. Gallo	P1-WEST-26 (if not 25)
128	Minimum boronization (B2D6 quantity) to restart WEST operations after a vent	A. Gallo	P1-WEST-26
129	Boronization with and without glow discharge at various wall temperatures in WEST	A. Gallo	P2-WEST-26
124	Development of ICWC boronization for ITER	E. Lerche	P1-AUG-26, P1-WEST-26
140	Preparation of B reference samples	T. Dittmar	P1-AUG-26-PB, P1-WEST-26-PB
125	Particle balance in AUG as a measure of global D retention in pulses following fresh boronisation	D. Matveev	P3-AUG
126	Estimation of H/D retention in boronized fusion devices through D-to-H-to-D changeover experiments in WEST	J. Denis	P1-WEST-27
122	Study about the outgassing of the deposit layer	J. Gerardin	P2-WEST
123	Impact of ICWC on plasma operation	E. Lerche	P2-AUG, P2-WEST
137	ICWC operation with TWA	R. Ragona	P2-WEST

Concluding remarks

- Proposals covering **high priority issues for ITER new baseline** with AUG/WEST cross machines comparison : runaway impact on first wall, boronisation
- Strong overbooking of both machines, so that only P1 proposals could be accomodated as main programme
- P1 proposals for WEST will need to be further streamlined (focus ➔ reduced number of shots) and/or refined (proposals in italic)
- Missing items ?
  - first wall W source, but activities under other RT (RT01, RT05) + analysis of first wall samples exposed in AUG in 2025
  - disruption heat loads (RT03) (fast IR in WEST)

<table>
<tr><th>RT06 R&D area</th><th>AUG</th><th>WEST</th></tr>
<tr><td rowspan="3">PFC evolution / damage (D1-D2)</td><td colspan="2">Runaway impact on first wall #116</td></tr>
<tr><td>Melting : gaps #114 + W alloy #115</td><td>Self castellation exposure # 135
OHS and gap loads #136</td></tr>
<tr><td></td><td>Power balance calorimetry #121</td></tr>
<tr><td rowspan="3">Material migration (D3)</td><td></td><td>Divertor Ti/Te # 138</td></tr>
<tr><td></td><td>TWA W source # 119</td></tr>
<tr><td></td><td>W migration 3D (PB) # 139</td></tr>
<tr><td rowspan="2">Fuel retention/recovery/ wall conditioning (D4-D5-D7)</td><td colspan="2">ICWC boronisation # 124 + sample # 140 (PWIE)</td></tr>
<tr><td>Boron powder injection # 117</td><td>Non uniform boro #127, min boro #128
H/D retention from boro # 126</td></tr>
<tr><td>Proposed P1 shots</td><td>49</td><td>364</td></tr>
<tr><td>Shot allocation*</td><td>56</td><td>240</td></tr>
</table>

* Tentative, to be re assessed after GPM

Italic : proposals need to be refined

Bold : technical feasibility to be confirmed

Now open for discussion !