EUROfusion

05 November 2025

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

Discussion on proposals and allocated priorities

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On behalf of WPTE TFLs
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Research Topic Coordinators
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This work has been carried out within the framework of the EUROfusion Consortium, funded by the European Union via the Euratom Research and Training Programme (Grant Agreement No 101052200 — EUROfusion). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.

Introduction

- The new scope of RT-07 is to
  - ✓ Provide input to the **design of future fusion devices** beyond ITER
  - ✓ **Expand the parameter space** for model and control validation
  - ✓ Improve **understanding on detachement** for the benefit of ITER
- RT-07 program will be executed on all the WPTE machines
  - ✓ **Characterize detachment** in different ADCs on AUG (2026) and perform **detailed physics studies** (2027)
  - ✓ Maximally utilize the **new TBLLD baffling** on TCV
  - ✓ **Functional H-mode scenario** on MAST-U
  - ✓ Complete **DN studies** on WEST

Scientific Objectives and Machine Time

Scientific Objectives	
D1	Determine the characteristics for plasma exhaust and scenario control as well as core compatibility in H-mode for different alternative divertor configurations (ADCs)
D2	Characterize possible benefits of snowflake and other ADCs with multiple X-point configurations for their X-point radiation stability and dissipated power in H-mode
D3	Quantify the degree of heat load mitigation during ELMs and other transients, achieved by impurity seeding, and investigate their dependences on relevant machine parameters
D4	Evaluate existing reduced SOL models against ADCs and validate core-edge, SOL and divertor models of increasing complexity against experimental data, for divertor optimisation as well as plasma exhaust understanding and control

Allocation of discharges (tentative)

	AUG	TCV	MAST-U	WEST
2026 + 2027	45 + 48	100 + 110	48 + 0	15 + 0
Proposed	193	404	199	32
Overbooking	2.1	1.9	4.1	2.1

Overview of proposals

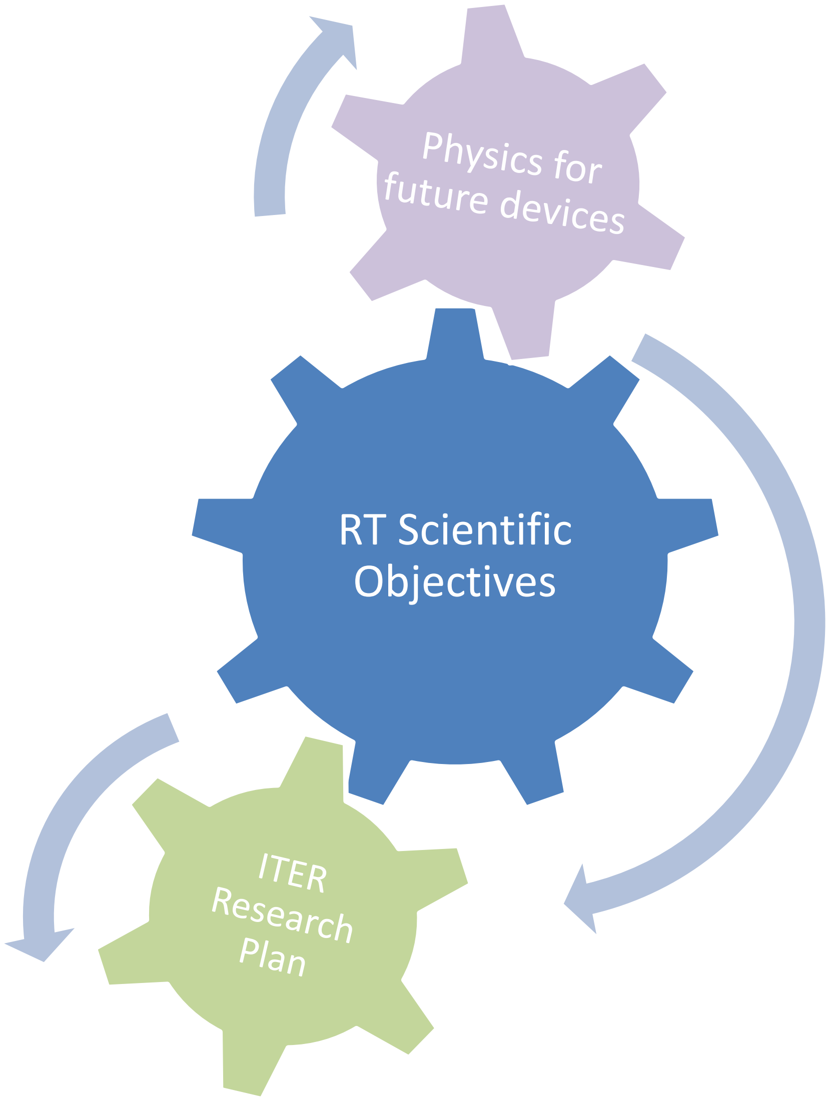
#	Title	Proponents
144	Impact of flux expansion on X-point radiator access and associated transport in ADCs in AUG	Ou Pan
161	Power sharing and transport in SF- configuration	Dominik Brida
162	AUG SF- configuration comparison between AUG and TCV	Dominik Brida
176	Super Compact Radiative Divertor at 1MA	Tilmann Lunt
177	Stability of the LFS SF- configuration during type-I ELMs	Tilmann Lunt
150	Nitrogen seeding scan for far SOL detachment in SF- at AUG	Alessandro Mancini
151	Nitrogen seeding scan for XD power exhaust investigation at AUG	Alessandro Mancini
152	Detachment study with positive and negative Bt at AUG	Alessandro Mancini
166	Study of detachment in L-Mode during systematic parameter sweep in ADCs	Felix Albrecht
149	Slow ADC configuration scan at AUG	Alessandro Mancini
142	I-mode access in alternative divertor configurations in ASDEX Upgrade	Davide Silvagni
143	High-radiative and detached I-mode in alternative divertor configuration in ASDEX Upgrade	Davide Silvagni
171	RMP effects on the access of detachment in super-x divertor and X-divertor configurations	Yunfeng Liang
145	Impact of the secondary X-point on the radial electric field in near SOL in SF- and super-CRD config.	Ou Pan
147	Interplay between X-point separation and power fall-off length in ASDEX Upgrade	Michael Faitsch
146	Far SOL transport and its interaction with W wall in ADCs in AUG	Ou Pan
141	Burn throughs in ADC in Hydrogen in AUG	Matthias Willensdorfer
167	ELM-resolved upper divertor profiles from spectroscopic measurements in ADCs at AUG	Hannah Lindt
170	Scrape-off layer fluctuation measurements in ADCs at AUG	William Fuller

AUG

Overview of proposals

	#	Title	Proponents
TCV	154	Optimization and Characterization of Power Exhaust at High Neutral Pressure in TCV’s TBLLD	Benjamin Brown
	155	Detachment Front Evolution in a Chimney-like Configuration	Benjamin Brown
	156	High power dissipation in TCV's Tightly-Baffled, Long-Legged Divertor (TBLLD)	Holger Reimerdes
	164	Power and Fuelling transients in the TBLLD	Olivier Février
	173	Characterisation of turbulence and transport in the TBLLD	Christian Theiler
	153	Characterization of turbulence in X-point radiator H-mode scenarios on TCV	Yinghan Wang
	157	Detachment in high-power NT scenarios leveraging ADCs on TCV	Garance Durr-Legoupil-Nicaud
	168	Impact of secondary X-point radial distance from the separatrix on the X-point target performance	Massimo Carpita
MAST-U	159	High-power core-edge integrated scenarios for ADC exploration	Kevin Verhaegh
	172	Impact of total flux expansion and divertor turbulence on PFR broadening	Peter Ryan
MULTIMACHINE	158	Outer target optimisation through poloidal & total flux expansion	Kevin Verhaegh
	160	Multi-machine study of power exhaust in the X-point target configuration	Kenneth Lee
	165	Impurity transport in strongly baffled ADCs	Nicola Lonigro
	174	Core-Divertor Integrated Power Exhaust Study with Impurities	Lingyan Xiang
	163	Effect of magnetic balance, divertor geometry, and fuelling/seeding location on radiation in DN plasmas	Nicola Lonigro
	148	ELM and transient buffering in ADCs of AUG, MAST-U, and TCV	Felix Albrecht
	175	Assess risk of reattachment during lost of DN magnetic balance in various ADCs for future reactors	Lingyan Xiang
	169	Dynamic response of ADCs to demonstrate reactor control & scenario integration benefits	Paulo Figueiredo

Prioritization scheme and criteria



Proposals 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: experimental priority in 2026

P1-2027: priority at a later stage

P2: will be done if time allows after compeleting P1-2026 and P1-2027 or if machine conditions make it possible

P3: back-up programme/not possible in 2026-2027

PB: piggy-back experiment/pure analysis proposal

AUG specific proposals

#144: Impact of flux expansion on X-point radiator access and associated transport in ADCs in AUG

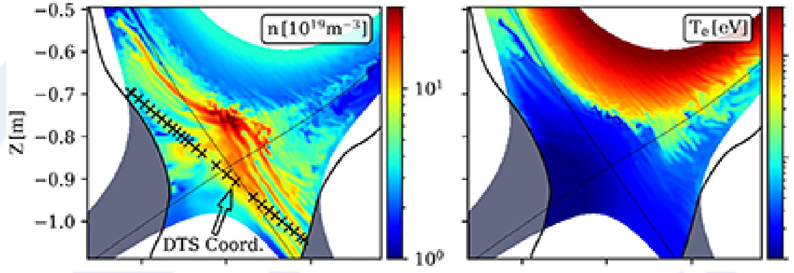
- **Proponents and contact person:**

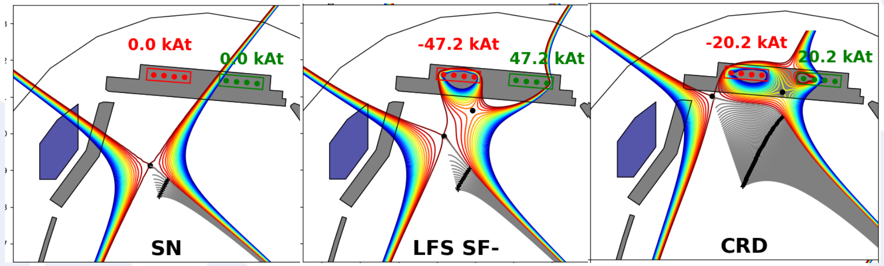
Ou Pan ou.pan@ipp.mpg.de, Y. C. Liang, M. Bernert, T. Lunt, B. Sieglin, D. Brida, M. Faitsch, S. Hörmann, G. Grenfell, F. Albrecht, M. Szücs, K. Eder, W. Fuller

- **Scientific Background & Objectives**
  - The XPR regime offers a promising solution to the power exhaust problem by combining divertor detachment with ELM mitigation. Analytical models [Stroth et al., NF 2022 / PPCF 2025] emphasize the role of magnetic flux expansion at the X-point in enabling XPR, and turbulence simulations [Eder et al., NF 2025] suggest enhanced radial transport structures in this region. It is therefore crucial to assess how X-point flux expansion affects XPR access, radiation efficiency, ELM mitigation thresholds, and transport, as well as its possible impact on confinement, using AUG's upper divertor with flexible configurations.
  - Compare XPR access conditions, ELM mitigation threshold and confinement performance in the XPR regime in ADCs with varying X-point flux expansion
  - Further refine and optimise the feedback control of the XPR position
  - Evaluate the maximum radiation fraction and the capability to withstand power transients with an XPR in ADCs
  - Diagnose edge modes and associated transport processes

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - A dedicated set of scenario development discharges is required to refine and optimize feedback control of the XPR position in the upper divertor.
  - In the upper SN divertor configuration, scan the XPR position until ELM suppression is achieved. Add a step of increasing heating power at the phase with maximum XPR height.
  - In LFS SF– divertor configurations, repeat the procedure with 2–3 different secondary X-point positions.
  - If the XPR position control is successfully developed in super-CRD, extend the procedure to this configuration.
  - Diagnostics: HEB, MEM, AXUV, TS, IR, LPs

[Eder et al., NF 2025]





Proposed pulses

Device	# Pulses/Session	# Development
AUG	6	6

#144: Impact of flux expansion on X-point radiator access and associated transport in ADCs in AUG

- **Proponents and contact person:**

Ou Pan ou.pan@ipp.mpg.de, Y. C. Liang, M. Bernert, T. Lunt, B. Sieglin, D. Brida, M. Faitsch, S. Hörmann, Grenfell, F. Albrecht, M. Szücs, K. Eder, W. Fuller

P1-AUG-2026

At the heart of the set RT-07 priorities, will have synergy with RT-05

- **Scientific Background & Objectives**
  - The XPR regime offers a promising solution to the power exhaust problem by combining divertor detachment with ELM mitigation. Analytical models [Stroth et al., NF 2022 / PPCF 2025] emphasize the role of magnetic flux expansion at the X-point in enabling XPR, and turbulence simulations [Eder et al., NF 2025] suggest enhanced radial transport structures in this region. It is therefore crucial to assess how X-point flux expansion affects XPR access, radiation efficiency, ELM mitigation thresholds, and transport, as well as its possible impact on confinement, using AUG's upper divertor with flexible configurations.
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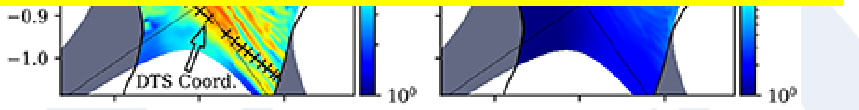
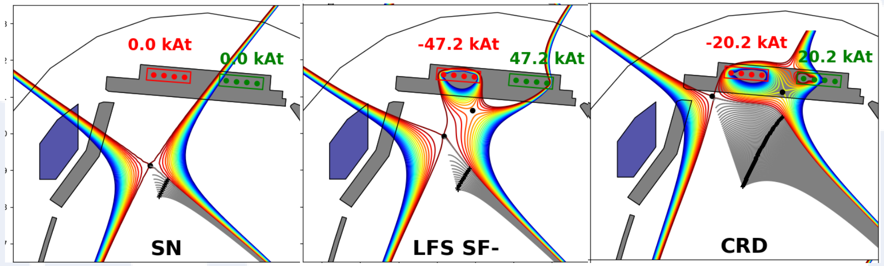
  - If the XPR position control is successfully developed in super-CRD, extend the procedure to this configuration.
  - Diagnostics: HEB, MEM, AXUV, TS, IR, LPs





Proposed pulses

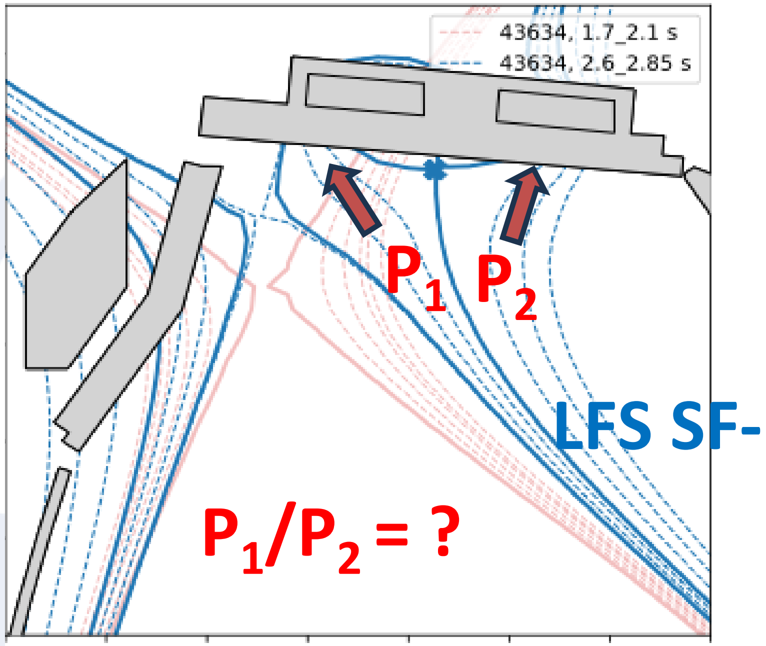
Device	# Pulses/Session	# Development
AUG	6	6

#161: Power sharing and transport in LFS SF-

- **Proponents and contact person:**

  dominik.brida@ipp.mpg.de

- **Scientific Background & Objectives**
  - Access low density attached SF- configuration in H-mode, while keeping the peak heat flux within safe limits.
  - Scan secondary X-point configuration (primary X-point distance ru,x2)
  - Obtain good IR heat flux profiles (additionally good LP, DTS and upstream profiles highly desired)
  - Analyse the data to characterise power sharing between strike-points.



Proposed pulses

Device	# Pulses/Session	# Development
AUG	10	0

#161: Power sharing and transport in LFS SF-

- **Proponents and contact person:**
  dominik.brida@ipp.mpg.de

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  - Scan secondary X-point configuration (primary X-point distance ru,x2)
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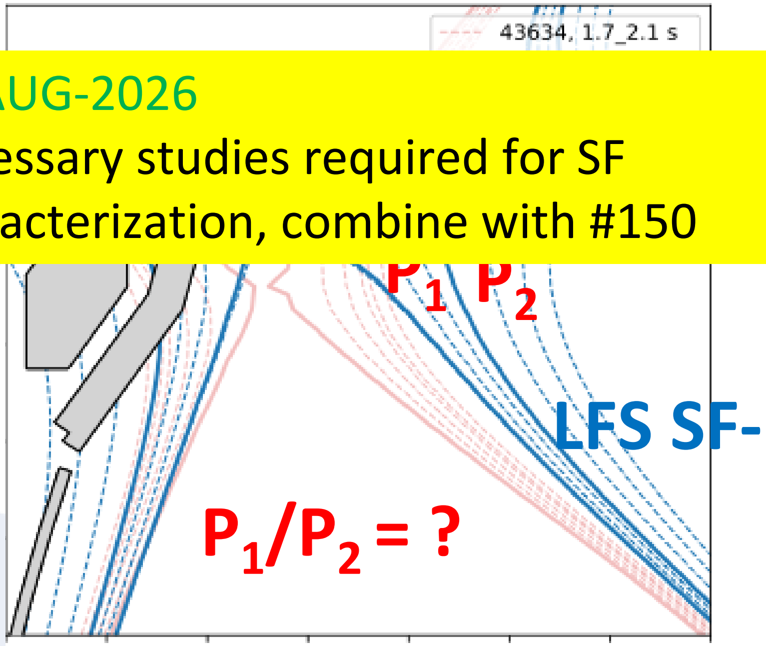
  - Analyse the data to characterise power sharing between strike-points.

P1-AUG-2026
Necessary studies required for SF characterization, combine with #150



Proposed pulses

Device	# Pulses/Session	# Development
AUG	10	0

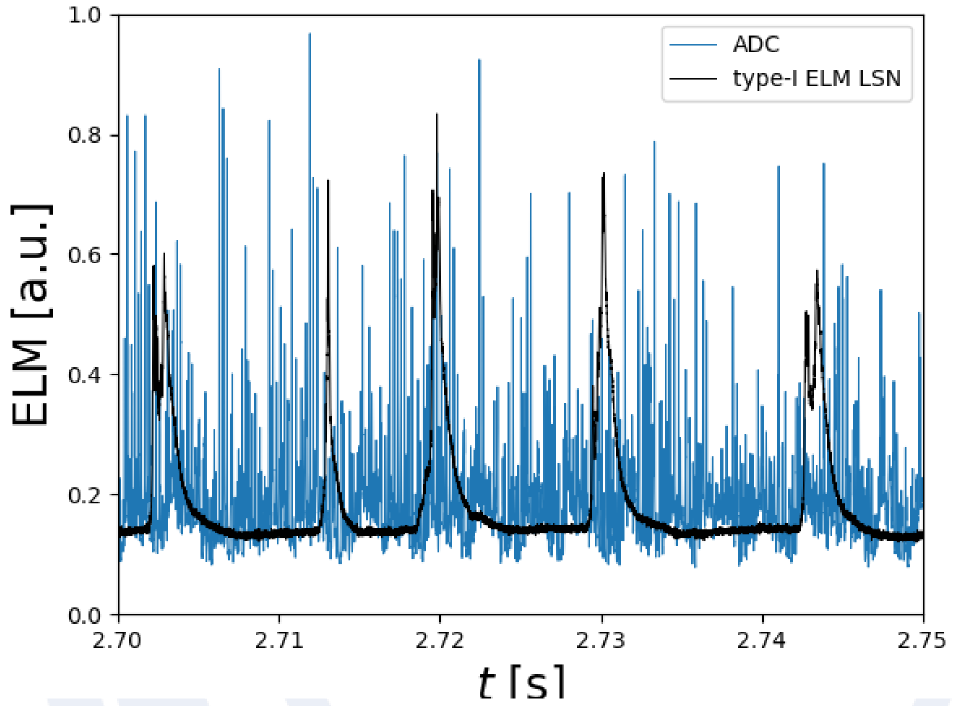
#177: Stability of the LFS SF- configuration during type-I ELMs

- **Proponents and contact person:**

tilmann.lunt@ipp.mpg.de

- **Scientific Background & Objectives**
  - Most (all?) of the ADC discharges in AUG in a small-ELM (QCE?) regime
  - This proposal aims at studying the LFS SF-configuration in a type-I ELM regime

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  – Develop type-I ELM regime in ADC trying the following options
  - Use the FoA gas valves in AUG to puff in the PFR (as opposed to the FoB used so far)
  - Operate just slightly above H-mode threshold, where ELMs are typically large
  - Moving the primary X-point (i.e. varying elongation and triangularity)
  – Acquire high quality edge profiles with the full-set of edge diagnostics (LP, IR, bolometry, spectroscopy, He-beam, TS and DTS, …)



Proposed pulses

Device	# Pulses/Session	# Development
AUG	8	2

#177: Stability of the LFS SF- configuration during type-I ELMs

- **Proponents and contact person:**

tilmann.lunt@ipp.mpg.de

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  - Most (all?) of the ADC discharges in AUG in a small-ELM (QCE?) regime
  - This proposal aims at studying the LFS SF-configuration in a type-I ELM regime

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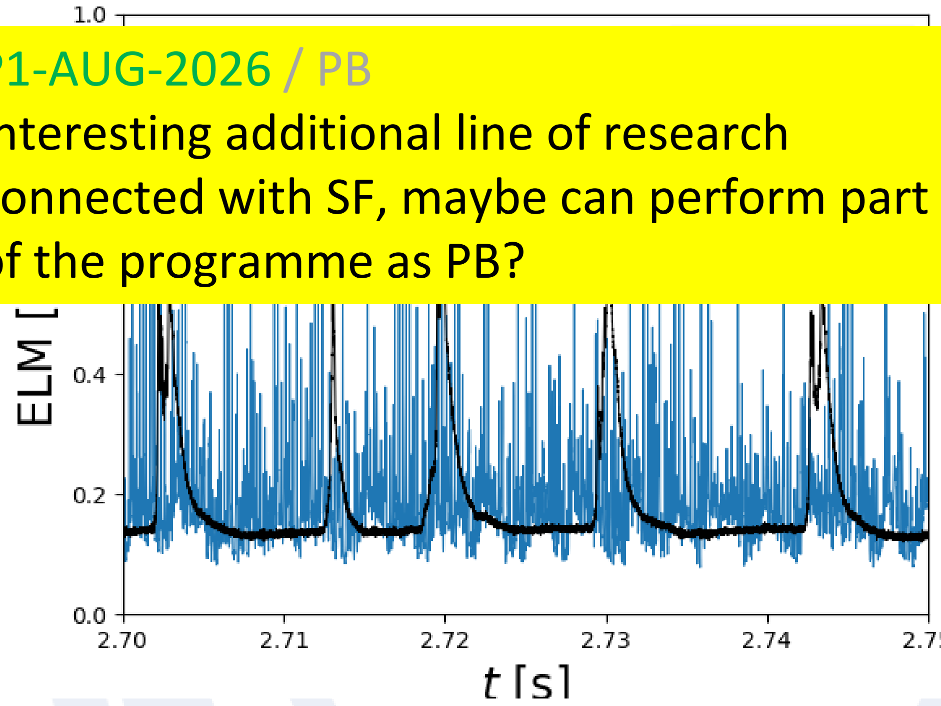
  - Acquire high quality edge profiles with the full-set of edge diagnostics (LP, IR, bolometry, spectroscopy, He-beam, TS and DTS, …)

P1-AUG-2026 / PB
Interesting additional line of research connected with SF, maybe can perform part of the programme as PB?



Proposed pulses

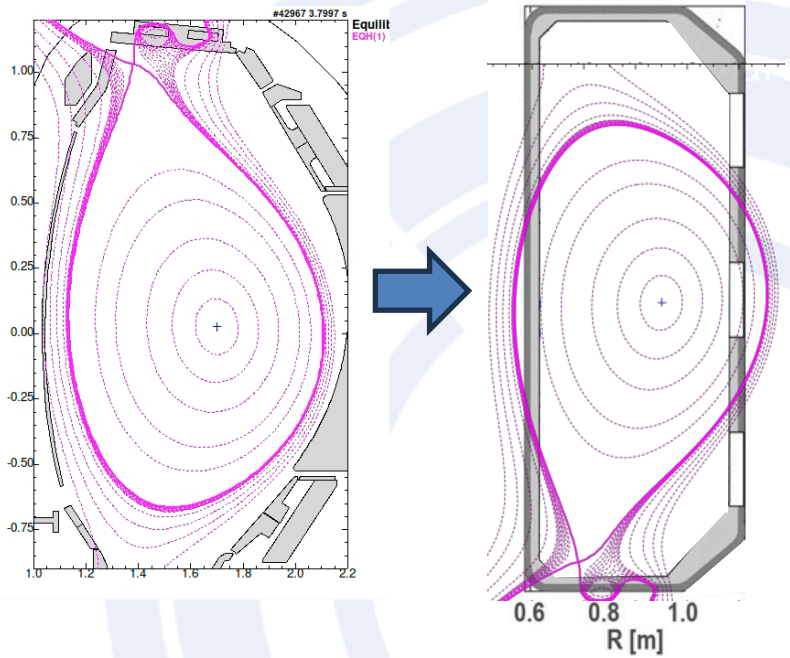
Device	# Pulses/Session	# Development
AUG	8	2

#162: AUG LSF SF- similarity experiments in AUG and TCV

- **Proponents and contact person:**

dominik.brida@ipp.mpg.de

- **Scientific Background & Objectives**
- Compare the detachment behavior in AUG and TCV in an AUG-SF⁻ similar divertor configuration.
- Determine whether the detachment behavior in the resulting configuration in TCV is more SF- or XPT-like.
- Investigate the effect of changes to the configuration such as strike-line orientation relative to the divertor target (which cannot be easily done AUG)



Proposed pulses

Device	# Pulses/Session	# Development
AUG	3	3
TCV	7	5

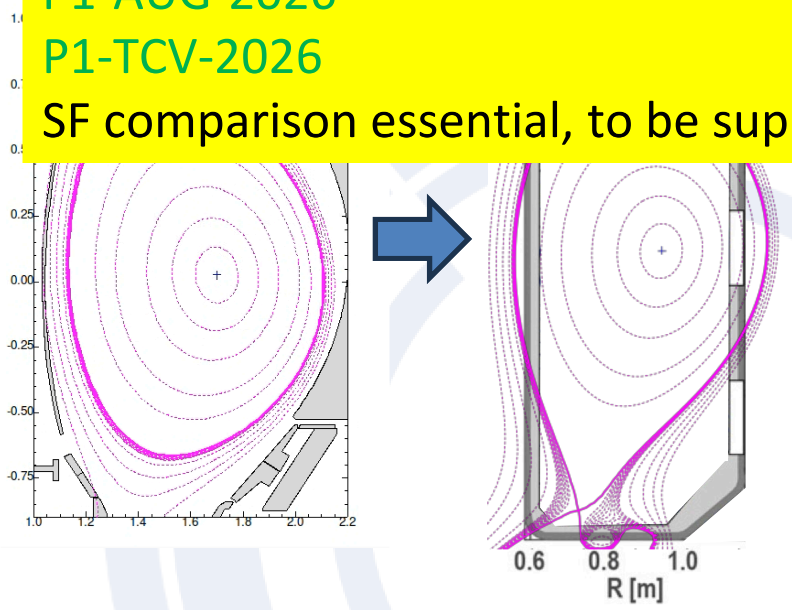
#162: AUG LSF SF- similarity experiments in AUG and TCV

- **Proponents and contact person:**

dominik.brida@ipp.mpg.de

- **Scientific Background & Objectives**
- Compare the detachment behavior in AUG and TCV in an AUG-SF⁻ similar divertor configuration.
- Determine whether the detachment behavior in the resulting configuration in TCV is more SF- or XPT-like.
- Investigate the effect of changes to the configuration such as strike-line orientation relative to the divertor target (which cannot be easily done AUG)

P1-AUG-2026
P1-TCV-2026
SF comparison essential, to be supported



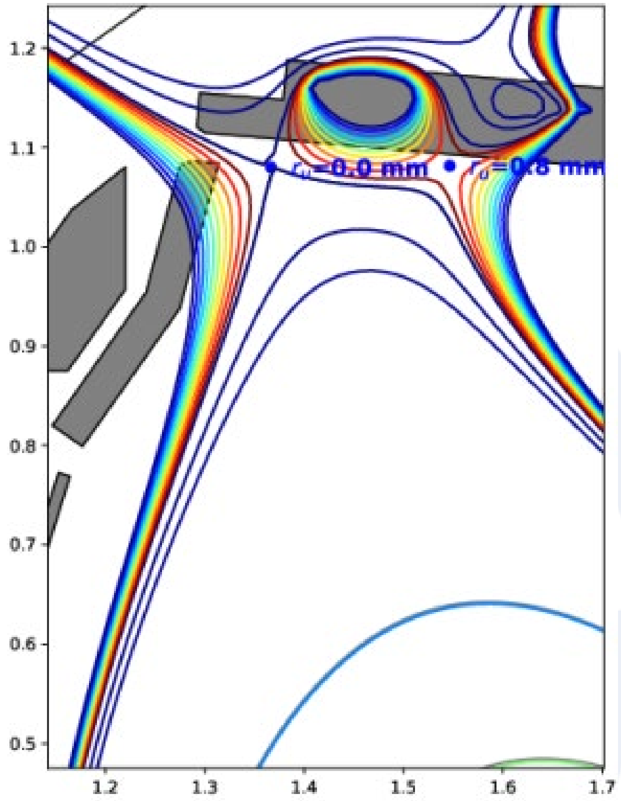
Proposed pulses

Device	# Pulses/Session	# Development
AUG	3	3
TCV	7	5

#176: Super CRD configuration at 1MA

- **Proponents and contact person:**
tilmann.lunt@ipp.mpg.de

- **Scientific Background & Objectives**
  - Establish the ‘super compact radiative divertor’ configuration at I_P=1MA
  - Compare the far-SOL heat fluxes to reference discharges at I_P=600 and 800 kA to test the dependence on the ratio of λ_q to the radial extension of the XPR volume Δr_{uXPR}
  - Measure heat and particle fluxes with IR and LP
  - Acquire high quality bolometry and spectroscopy data in the divertor volume
  - Identify the ELM regime (type I,II or II, QCE, …)
  - Test the robustness by varying the discharge conditions (density, puffing and seeding levels and positions,…)



Proposed pulses

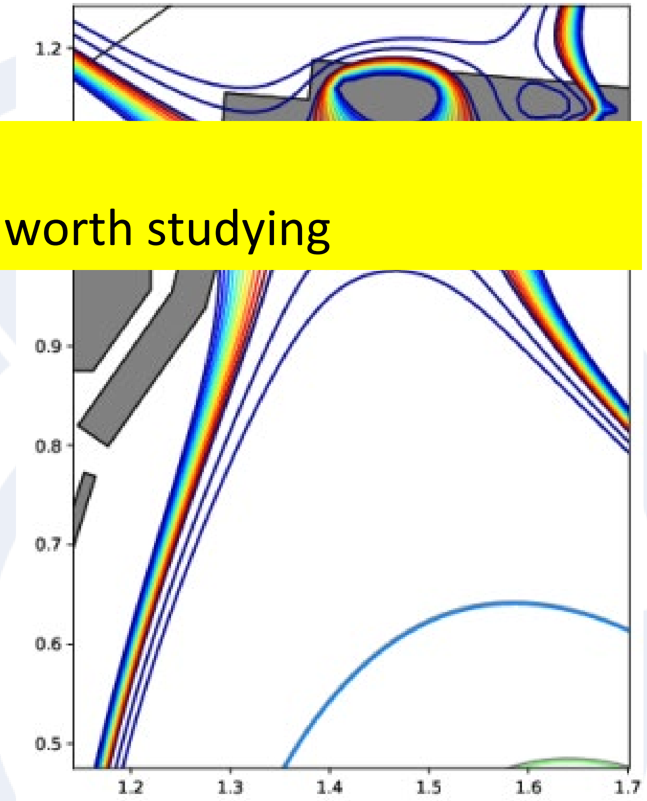
Device	# Pulses/Session	# Development
AUG	12	8

#176: Super CRD configuration at 1MA

- **Proponents and contact person:**
tilmann.lunt@ipp.mpg.de

- **Scientific Background & Objectives**
  – Establish the ‘super compact radiative divertor’ configuration at I_P=1MA
  – Compare the far-SOL heat fluxes to reference discharges at I_P=600 and 800 kA to test the dependence on the ratio of λ_q to the radial extension of the XPR volume Δr_{uXPR}
  – Measure heat and particle fluxes with IR and LP
  – Acquire high quality bolometry and spectroscopy data in the divertor volume
  – Identify the ELM regime (type I,II or II, QCE, …)
  – Test the robustness by varying the discharge conditions (density, puffing and seeding levels and positions,…)

P1-AUG-2026
sCRD identified worth studying



Proposed pulses

Device	# Pulses/Session	# Development
AUG	12	8

#150: Nitrogen seeding scan for far SOL detachment in LFS SF- at AUG

- **Proponents and contact person:**

A. Mancini (alessandro.mancini@ipp.mpg.de) et al.

- **Scientific Background & Objectives**

  During the last AUG experimental campaign it was found that the outer far SOL of LFS SF- configuration is difficult to detach, producing high heat loads on the divertor target. The aim of this proposal is to use N seeding ramps with LFS SF- at AUG to assess if and at what seeding rate the far SOL detaches.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Start from a SF- configuration with 0.8 MA/2.5 T and perform a nitrogen seeding scan. Repeat with increased heating power [2# + 1# backup]
  - repeat with increased plasma current [2# + 1# backup]

  Therefore 6 shots are requested for physical investigation.

  The analysis requires bolometric and Langmuir probes measurements to observe detachment.

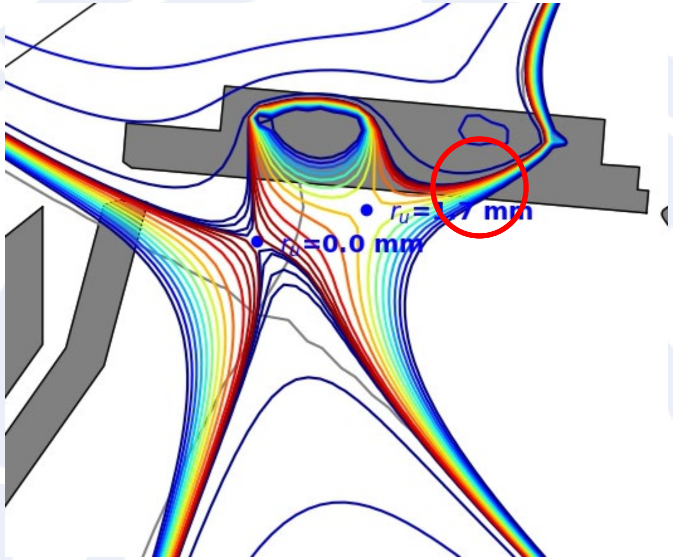


Fig. 1: LFS SF- with far SOL highlighted in red

Proposed pulses

Device	# Pulses/Session	# Development
AUG	6	

#150: Nitrogen seeding scan for far SOL detachment in LFS SF- at AUG

P1-AUG-2026
Impact of N seeding need to be studied, combine with #161

- **Proponents and contact person:**

A. Mancini (alessandro.mancini@ipp.mpg.de) et al.

- **Scientific Background & Objectives**

  During the last AUG experimental campaign it was found that the outer far SOL of LFS SF- configuration is difficult to detach, producing high heat loads on the divertor target. The aim of this proposal is to use N seeding ramps with LFS SF- at AUG to assess if and at what seeding rate the far SOL detaches.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Start from a SF- configuration with 0.8 MA/2.5 T and perform a nitrogen seeding scan. Repeat with increased heating power [2# + 1# backup]
  - repeat with increased plasma current [2# + 1# backup]

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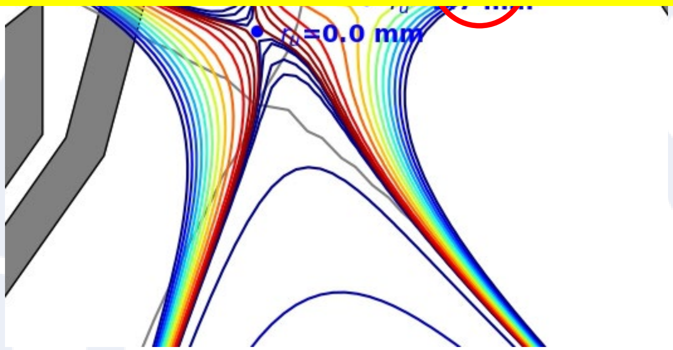

Fig. 1: LFS SF- with far SOL highlighted in red

Proposed pulses

Device	# Pulses/Session	# Development
AUG	6	

#151: Nitrogen seeding scan for XD power exhaust investigations at AUG

- **Proponents and contact person:**

A. Mancini (alessandro.mancini@ipp.mpg.de) et al.

- **Scientific Background & Objectives**

  The strength of the XD configuration is the volume with increased flux expansion close to the divertor target (see Fig. 1). This volume is of particular importance since it provides longer magnetic connection length, spreading of the heating power and enhanced radiative cooling. The aim of this proposal is to study the radiative exhaust capability and detachment characteristics of the XD configuration. Particular attention is posed to where EM radiation is produced and to the detachment front tracking. The behaviour is investigated at different heating powers and λ_q.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Develop a close-to-ideal XD configuration, if not previously done by other proposals [2# scenario development]
  - Start from a XD configuration with 0.8 MA/2.5 T and perform a nitrogen seeding scan. Repeat with increased heating power [2# + 1# backup]
  - repeat with increased plasma current [2# + 1# backup]

  Therefore 8 shots are requested: 6 for physical investigation, 2 for scenario development.
  The analysis requires bolometric and Langmuir probes measurements.

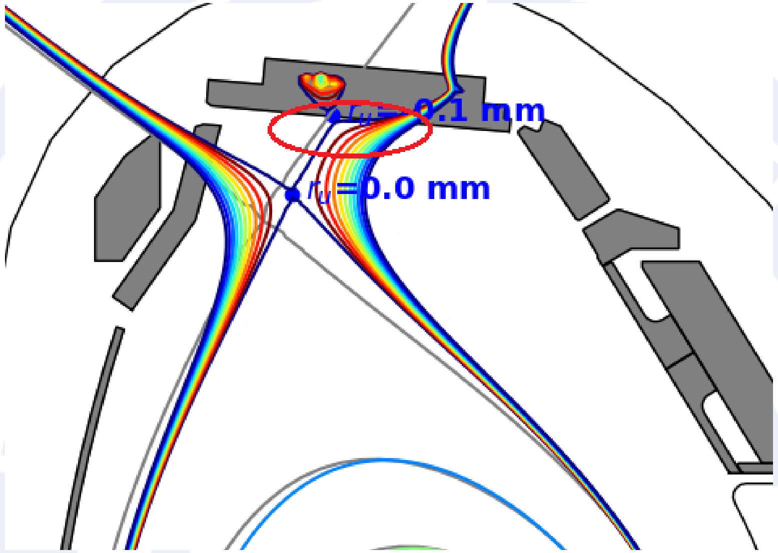

Fig. 1: XD with target volume highlighted in red

Proposed pulses

Device	# Pulses/Session	# Development
AUG	6	2

#151: Nitrogen seeding scan for XD power exhaust investigations at AUG

- **Proponents and contact person:**

A. Mancini (alessandro.mancini@ipp.mpg.de) et al.

- **Scientific Background & Objectives**

  The strength of the XD configuration is the volume with increased flux expansion close to the divertor target (see Fig. 1). This volume is of particular importance since it provides longer magnetic connection length, spreading of the heating power and enhanced radiative cooling. The aim of this proposal is to study the radiative exhaust capability and detachment characteristics of the XD configuration. Particular attention is posed to where EM radiation is produced and to the detachment front tracking. The behaviour is investigated at different heating powers and λ_q.

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  - repeat with increased plasma current [2# + 1# backup]

  Therefore 8 shots are requested: 6 for physical investigation, 2 for scenario development. The analysis requires bolometric and Langmuir probes measurements.

P1-AUG-2026
Also in XD configuration seeding studies part of fundamental characterization

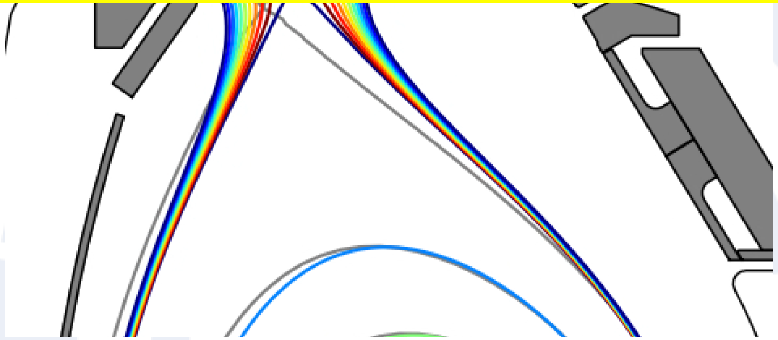


Fig. 1: XD with target volume highlighted in red

Proposed pulses

Device	# Pulses/Session	# Development
AUG	6	2

#152: Detachment study with in favourable and unfavourable magnetic field direction in the LFS SF- at AUG

- **Proponents and contact person:**

A. Mancini (alessandro.mancini@ipp.mpg.de) et al.

- **Scientific Background & Objectives**

The toroidal magnetic field orientation (+/- B_t) determines the particles' drift direction in the divertor region. This affects the particle densities in the inner and outer divertor legs, which, in turn, affects the detachment characteristics. We plan to study the impact of the drifts in the LFS SF- configuration, and how the drift direction influences the balance between the outer two strike lines.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Develop a LFS SF- in unfavourable B field direction (compensating inaccuracies in the magnetic equilibrium shape when changing field) matching existing LFS SF- shots [2#]
  - Perform two shots (in both field directions) with D fuelling ramps, to find the fuelling rates that give comparable upstream densities [2# + 1# backup]
  - Perform two shots (+B_t, -B_t) with LFS SF- with the selected D fuelling rates and a N seeding ramp to induce detachment [2#]
  - Repeat with increased heating power [2#]

Therefore 9 shots are requested, of which 5 for scenario development.

The analysis requires bolometric and Langmuir probes measurements.

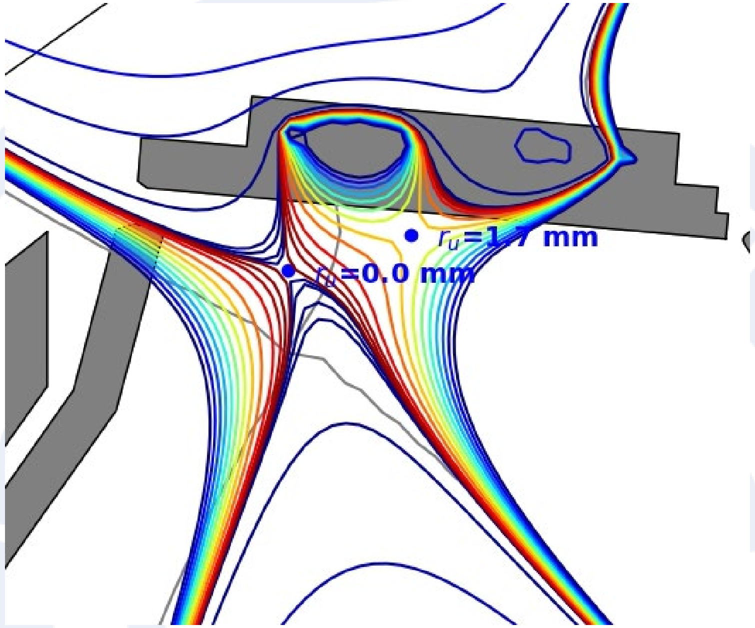


Fig. 1: LFS SF- configuration at AUG

Proposed pulses

Device	# Pulses/Session	# Development
AUG	4	5

#152: Detachment study with in favourable and unfavourable magnetic field direction in the LFS SF- at AUG

P2-AUG
Clear proposal, provides a benchmarking case for modelling but only after the other scans are completed

- **Proponents and contact person:**

A. Mancini (alessandro.mancini@ipp.mpg.de) et al.

- **Scientific Background & Objectives**

  The toroidal magnetic field orientation (+/- B_t) determines the particles' drift direction in the divertor region. This affects the particle densities in the inner and outer divertor legs, which, in turn, affects the detachment characteristics. We plan to study the impact of the drifts in the LFS SF- configuration, and how the drift direction influences the balance between the outer two strike lines.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Develop a LFS SF- in unfavourable B field direction (compensating inaccuracies in the magnetic equilibrium shape when changing field) matching existing LFS SF- shots [2#]
  - Perform two shots (in both field directions) with D fuelling ramps, to find the fuelling rates that give comparable upstream densities [2# + 1# backup]
  - Perform two shots (+B_t, -B_t) with LFS SF- with the selected D fuelling rates and a N seeding ramp to induce detachment [2#]
  - Repeat with increased heating power [2#]

  Therefore 9 shots are requested, of which 5 for scenario development.
  The analysis requires bolometric and Langmuir probes measurements.

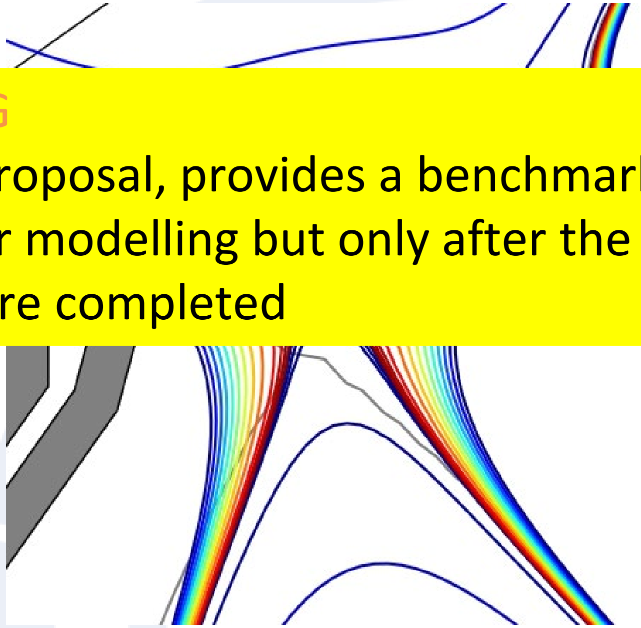


Fig. 1: LFS SF- configuration at AUG

Proposed pulses

Device	# Pulses/Session	# Development
AUG	4	5

#166: Detachment in L-Mode in ADCs in AUG

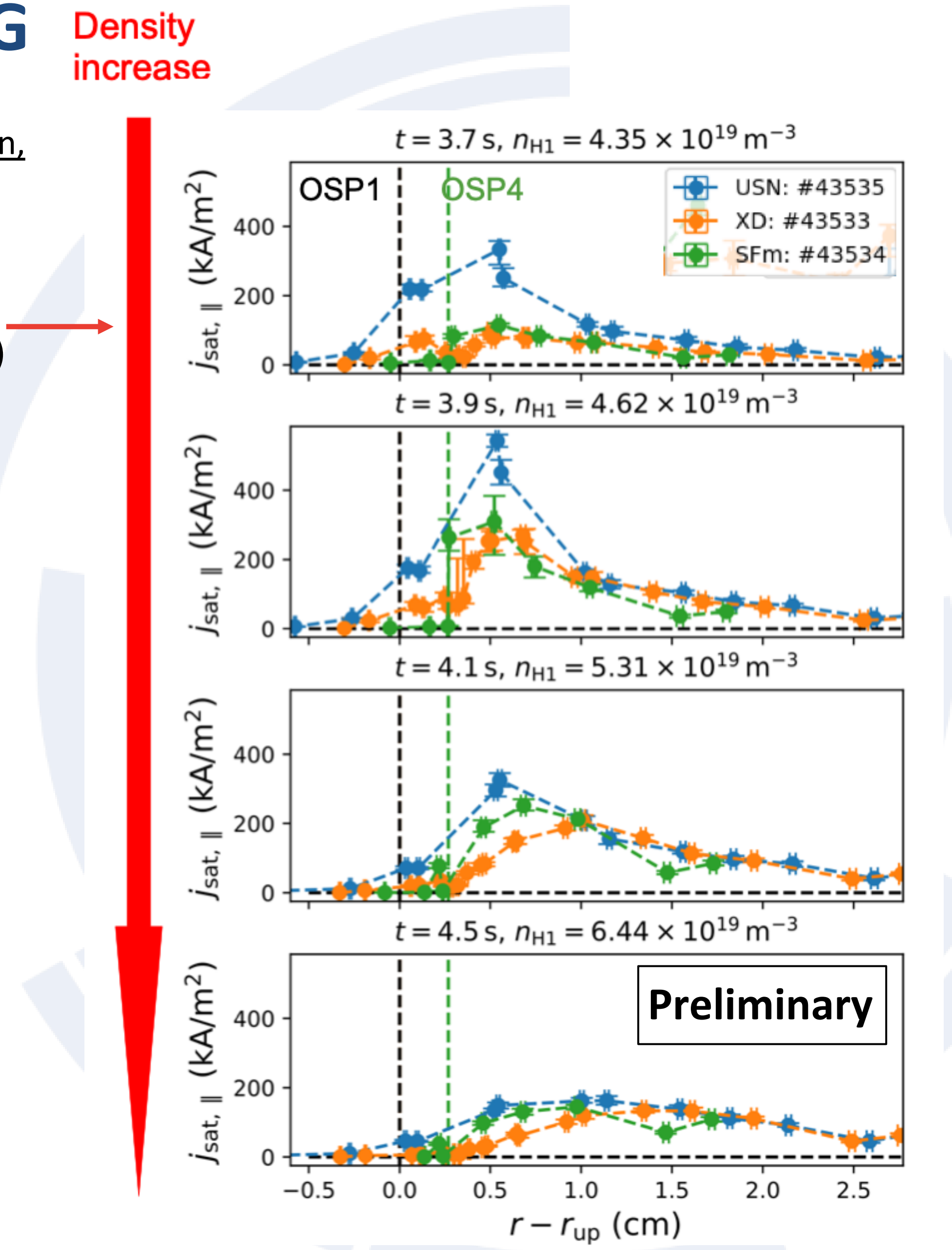
Proponents and contact persons:
AUG: Felix Albrecht (felix.albrecht@ipp.mpg.de), D. Brida, H. Lindl, A. Mancini, T. Lunt, B. Sieglin, O. Pan, M. Faitsch

Scientific Background
1. Dependence of detachment on flux expansion and field configuration [Lunt et al., NME 2021]
2. Lower ion fluxes were observed for ADCs in L-Mode density scans in $+B_t$ (see right figure)
3. Ion drifts, depending on $+/-B_t$, identified as possible reason [Carpita, invited talk AAPPS 2025]

Objectives
Linked to RT07 D1 and D4: Plasma exhaust and modelling in ADC

1. Characterize divertor plasma and exhaust performance in dependence of dr_{x2}
2. Perform SOLPS simulations (O. Pan) to investigate physical mechanisms
3. Compare with reduced models, e.g. [Body et al., NF 2025]

Experimental Strategy/Machine Constraints and essential diagnostic
- Compare divertor particle and power flux in + and $-B_t$, during fuelling steps
- **Diagnostics.: IR, LPs, Bolometry, Divertor Spectroscopy, Thomson Scattering**
- **Heating. ECRH**



Device	# Pulses/Session	# Development
AUG	5	2

#166: Detachment in L-Mode in ADCs in AUG

Density increase

Proponents and contact persons:
AUG: Felix Albrecht (felix.albrecht@ipp.mpg.de), D. Brida, H. Lindl, A. Mancini, T. Lunt, B. Sie
O. Pan, M. Faitsch

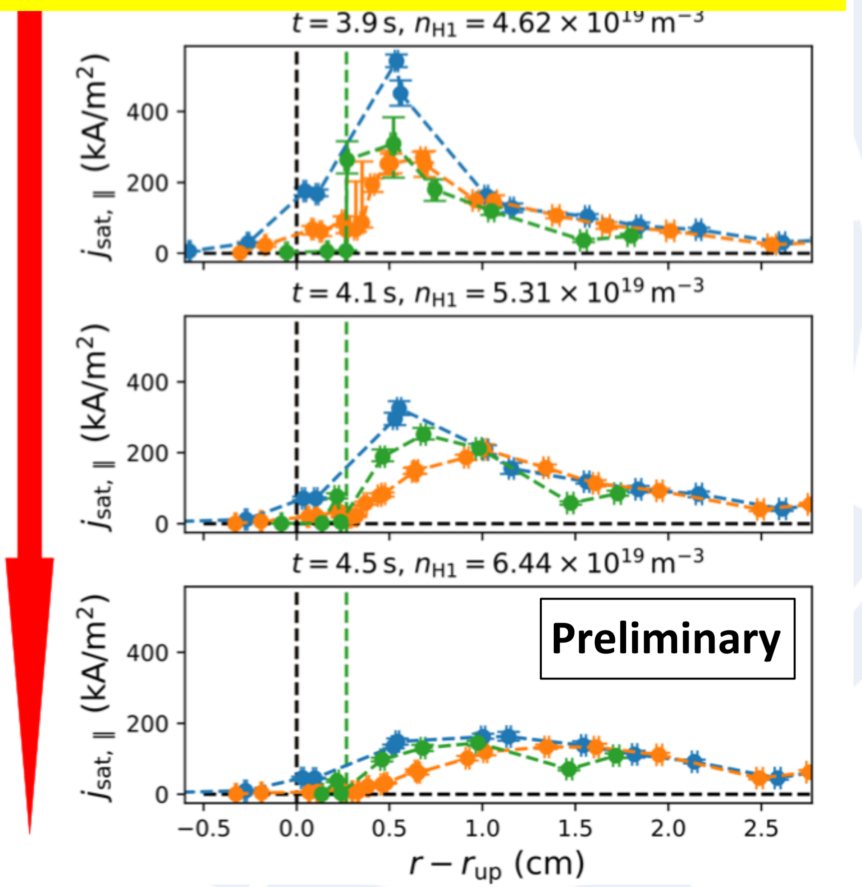
P2-AUG
Similar rating as for #152 but includes more scans, can consider combining with other proposals

Scientific Background
1. Dependence of detachment on flux expansion and field configuration [Lunt et al., NM 2021]
2. Lower ion fluxes were observed for ADCs in L-Mode density scans in $+B_t$ (see right figu
3. Ion drifts, depending on $+/-B_t$, identified as possible reason [Carpita, invited talk AAPPS 2025]

Objectives
Linked to RT07 D1 and D4: Plasma exhaust and modelling in ADC

1. Characterize divertor plasma and exhaust performance in dependence of dr_{x2}
2. Perform SOLPS simulations (O. Pan) to investigate physical mechanisms
3. Compare with reduced models, e.g. [Body et al., NF 2025]

Experimental Strategy/Machine Constraints and essential diagnostic
- Compare divertor particle and power flux in + and $-B_t$, during fuelling steps
- **Diagnostics.: IR, LPs, Bolometry, Divertor Spectroscopy, Thomson Scattering**
- **Heating. ECRH**



Device	# Pulses/Session	# Development
AUG	5	2

#149: Slow ADC configuration scan at AUG

- **Proponents and contact person:**

A. Mancini (alessandro.mancini@ipp.mpg.de) et al.

- **Scientific Background & Objectives**

  During the last AUG campaign bolometric analyses showed that radiation undergoes sudden and fast transients (~ 50 – 100 ms) when a SF- configuration is established. In particular, radiation moves from close to the primary X-point and strikelines to close to the 2nd X-point (Fig. 1, 2). It is unclear which factor provokes this radiation pattern change: whether the position of the 2nd separatrix or of the 2nd X-point.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Start from a SF- configuration with 0.8 MA/2.5 T and scan the 2nd X-point [1#]
  - repeat with a scan of the 2nd separatrix position [1# + 1# backup]
  - repeat with low N seeding level [2# +1# backup]
  - repeat with higher N seeding level [2# + 1# backup]

  Therefore 9 shots are requested for physical investigation.

  The analysis require bolometric measurements

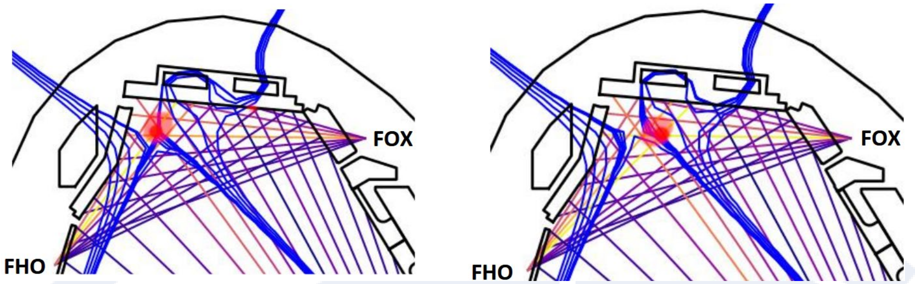


Fig. 1: radiation transition happening in 100 ms

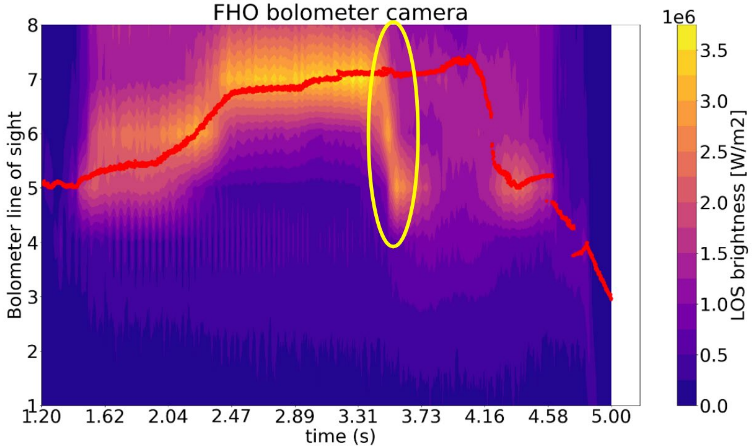
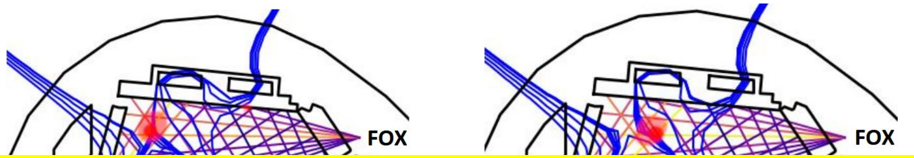


Fig. 2: FHO contour plot. 1st Xpt position in red

Proposed pulses

Device	# Pulses/Session	# Development
AUG	9	

#149: Slow ADC configuration scan at AUG



P2-AUG / PB
Includes more advanced scans than the other seeding proposals, consider if some of the studies can be done PB?

- **Proponents and contact person:**

A. Mancini (alessandro.mancini@ipp.mpg.de) et al.

- **Scientific Background & Objectives**

  During the last AUG campaign bolometric analyses showed that radiation undergoes sudden and fast transients (~ 50 – 100 ms) when a SF- configuration is established. In particular, radiation moves from close to the primary X-point and strikelines to close to the 2nd X-point (Fig. 1, 2). It is unclear which factor provokes this radiation pattern change: whether the position of the 2nd separatrix or of the 2nd X-point.

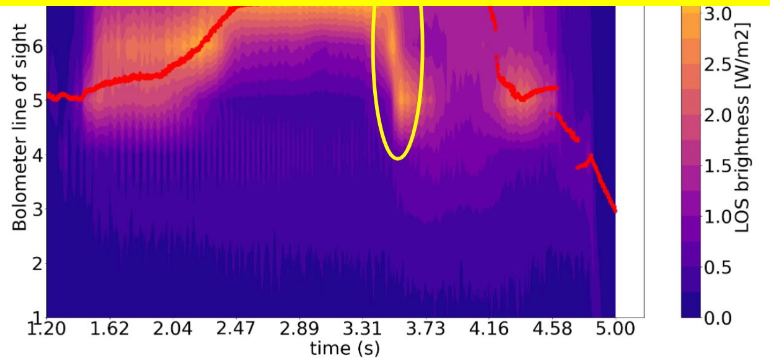


Fig. 2: FHO contour plot. 1st Xpt position in red

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Start from a SF- configuration with 0.8 MA/2.5 T and scan the 2nd X-point [1#]
  - repeat with a scan of the 2nd separatrix position [1# + 1# backup]
  - repeat with low N seeding level [2# +1# backup]
  - repeat with higher N seeding level [2# + 1# backup]

  Therefore 9 shots are requested for physical investigation.

  The analysis require bolometric measurements

Proposed pulses

Device	# Pulses/Session	# Development
AUG	9	

#142: I-mode access in alternative divertor configurations in ASDEX Upgrade

- **Proponents and contact person:**

D. Silvagni (davide.silvagni@ipp.mpg.de), O. Grover, A. Hubbard, … (full list in wiki)

- **Scientific Background & Objectives**

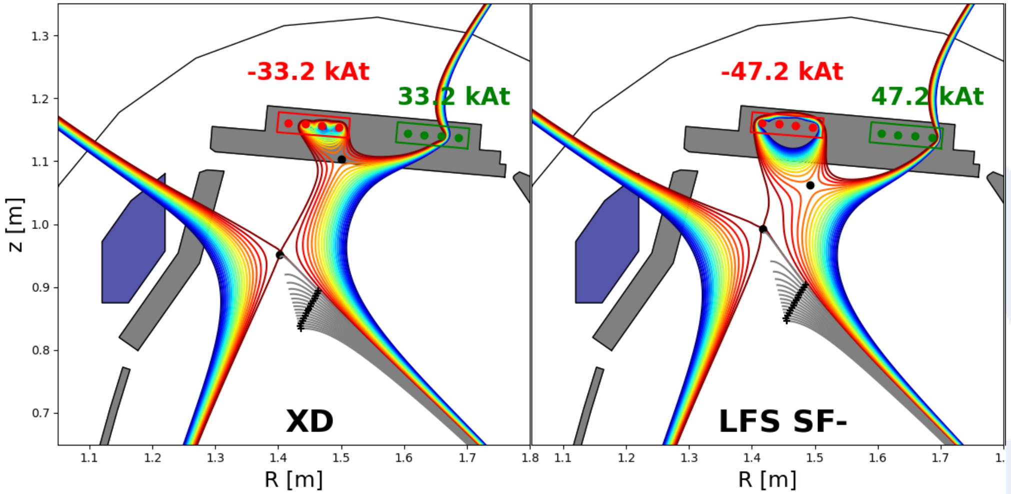
I-mode compatibility with divertor detachment and high-radiation fractions of uttermost importance for DEMO. ADC could facilitate detachment achievement, and allow high-radiation fraction in the SOL in I-mode plasmas. This proposal aims at accessing stable I-modes in X-divertor (XD) and low field side snowflake minus (LFS SF-) configurations at different density levels. The most promising I-mode scenario and divertor configuration to be used for detachment studies will be determined.

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

For each divertor configuration (XD and LFS SF-):

- Start from a well developed ADC shape at 0.8 MA / 2.5 T in reversed field (-2.5 T) with slow NBI power scan and constant density to find I-mode window [1]
- Repeat at three different constant densities [3]
- Keep I-mode stationary with beta_pol feedback control at the most promising density level (unseeded reference) [1]

Therefore 10 shots in total (5 for XD and 5 for LFS SF-).



Proposed pulses

Device	# Pulses/Session	# Development
AUG	10	

#142: I-mode access in alternative divertor configurations in ASDEX Upgrade

- **Proponents and contact person:**

D. Silvagni (davide.silvagni@ipp.mpg.de), O. Grover, A. Hubbard, … (full list in wiki)

- **Scientific Background & Objectives**

I-mode compatibility with divertor detachment and high-radiation fractions of uttermost importance for DEMO. ADC could facilitate detachment achievement, and allow high-radiation fraction in the SOL in I-mode plasmas. This proposal aims at accessing stable I-modes in X-divertor (XD) and low field side snowflake minus (LFS SF-) configurations at different density levels. The most promising I-mode scenario and divertor configuration to be used for detachment studies will be determined.

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

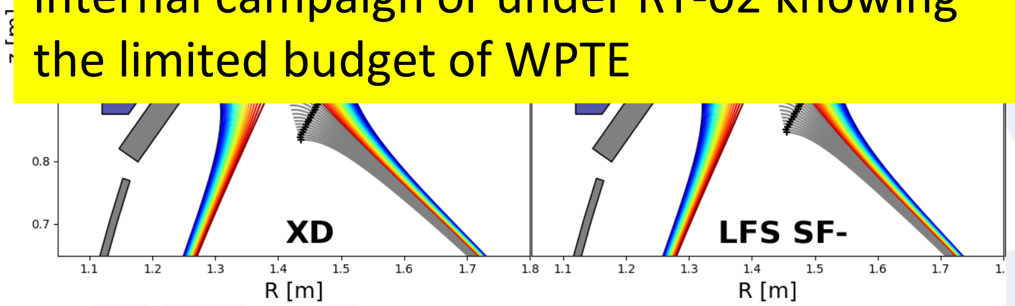
For each divertor configuration (XD and LFS SF-):

- Start from a well developed ADC shape at 0.8 MA / 2.5 T in reversed field (-2.5 T) with slow NBI power scan and constant density to find I-mode window [1]
- Repeat at three different constant densities [3]
- Keep I-mode stationary with beta_pol feedback control at the most promising density level (unseeded reference) [1]

Therefore 10 shots in total (5 for XD and 5 for LFS SF-).

P2-AUG

I-mode development and basic characterization should be rather under internal campaign or under RT-02 knowing the limited budget of WPTE



Proposed pulses

Device	# Pulses/Session	# Development
AUG	10	

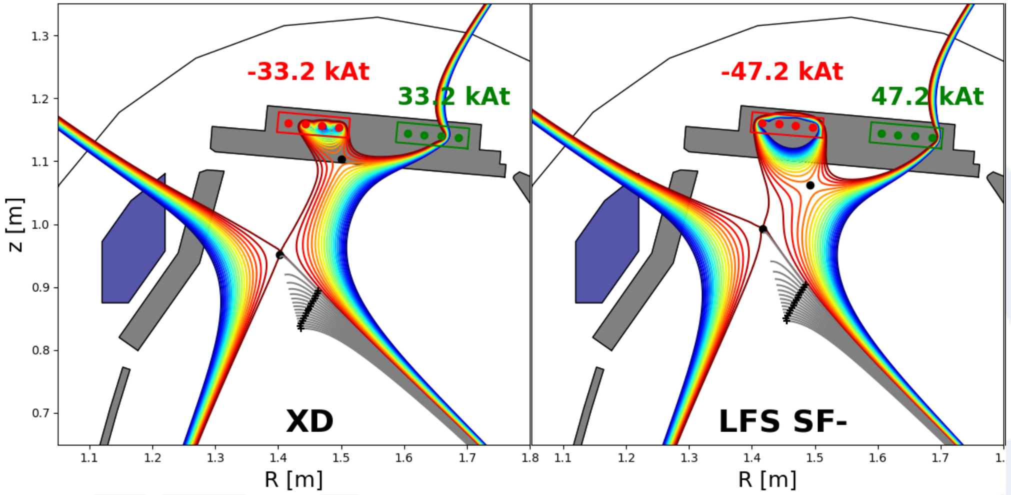
#143: High-radiative and detached I-mode plasmas in alternative divertor configuration in ASDEX Upgrade

- **Proponents and contact person:**

D. Silvagni (davide.silvagni@ipp.mpg.de), O. Grover, A. Hubbard, … (full list in wiki)

- **Scientific Background & Objectives**

I-mode compatibility with divertor detachment and high-radiation fractions of uttermost importance for DEMO. ADC could facilitate detachment achievement, and allow high-radiation fraction in the SOL in I-mode plasmas. This proposal aims at obtaining a high-radiative and detached I-mode scenario in an ADC with nitrogen seeding.



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

For the most promising I-mode scenario in terms of divertor configuration and density level (determined in this proposal WPTE wikipages: Call for proposals 2026: RT07 proposals:I-mode ADC):

- Apply nitrogen seeding at different constant seeding rates (four levels), while keeping required beta_pol constant [4]
- If I-L back-transition occurs, apply nitrogen seeding at different seeding rates with linear ramp in beta_pol, i.e. with an increase in heating power (successful strategy in previous single null experiments) [4]
- Optimize nitrogen seeding and required beta_poloidal trajectories, in order to get a stable, detached, high-radiative I-mode plasmas [1]

Therefore 9 shots in total.

Proposed pulses

Device	# Pulses/Session	# Development
AUG	9	

#143: High-radiative and detached I-mode plasmas in alternative divertor configuration in ASDEX Upgrade

- **Proponents and contact person:**

D. Silvagni (davide.silvagni@ipp.mpg.de), O. Grover, A. Hubbard, … (full list in wiki)

- **Scientific Background & Objectives**

I-mode compatibility with divertor detachment and high-radiation fractions of uttermost importance for DEMO. ADC could facilitate detachment achievement, and allow high-radiation fraction in the SOL in I-mode plasmas. This proposal aims at obtaining a high-radiative and detached I-mode scenario in an ADC with nitrogen seeding.

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

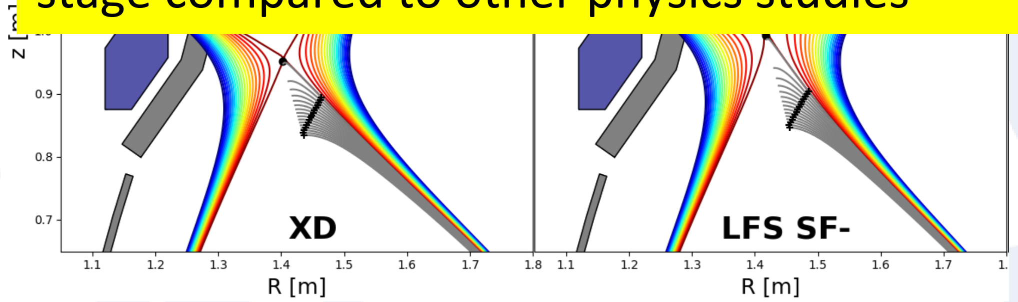
For the most promising I-mode scenario in terms of divertor configuration and density level (determined in this proposal WPTE wikipages: Call for proposals 2026: RT07 proposals:I-mode ADC):

- Apply nitrogen seeding at different constant seeding rates (four levels), while keeping required beta_pol constant [4]
- If I-L back-transition occurs, apply nitrogen seeding at different seeding rates with linear ramp in beta_pol, i.e. with an increase in heating power (successful strategy in previous single null experiments) [4]
- Optimize nitrogen seeding and required beta_poloidal trajectories, in order to get a stable, detached, high-radiative I-mode plasmas [1]

Therefore 9 shots in total.

P1-AUG-2027

Support the physics characterization of selected I-mode scenario but at a later stage compared to other physics studies



Proposed pulses

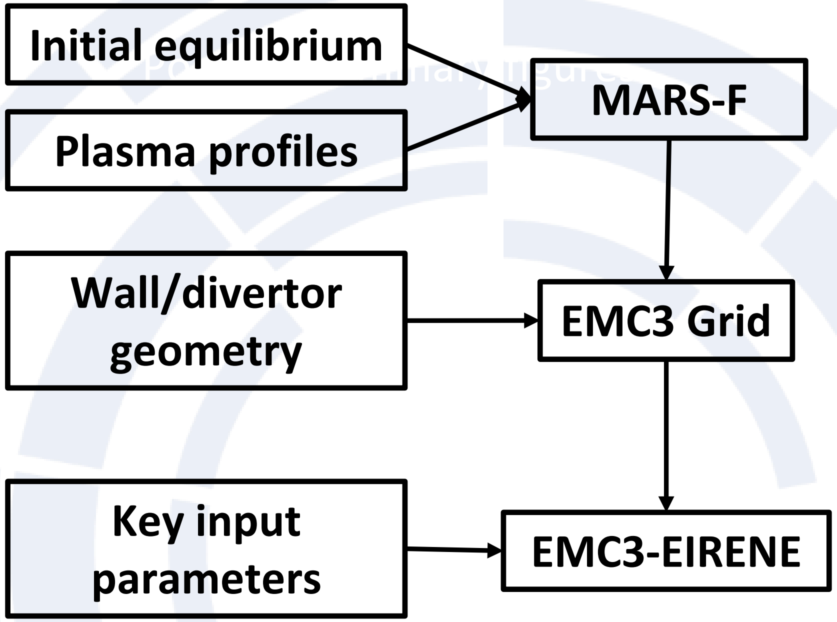
Device	# Pulses/Session	# Development
AUG	9	

#171: RMP effects on the access of detachment in super-x divertor and X-divertor configurations

- **Proponents and contact person:**

y.liang@fz-juelich.de

- **Scientific Background & Objectives**
  – Previous studies have found that RMPs has significant impacts on accessing detachment in traditional divertor configurations
  – Evaluating the effect of RMPs on detachment in super-X (MAST-U) and XD (ASDEX-U) configurations
  – Investigating the influences of plasma response on divertor heat flux distributions under different RMP phases
  – Validating the MARS/EMC3-EIRENE modeling strategy by comparisons with experimental data
- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - On MAST-U with super-X divertor, focusing on n=1 RMPs with a phase of ΔΦ = 0
    - Perform density ramp-up with mid-plane puffing (or divertor puffing) without RMPs and with RMPs in H-mode plasmas
    - Perform divertor puffing without RMPs and with RMPs in H-mode plasmas
  - On ASDEX-U with X-divertor, focusing on the n=2 RMPs
    - Perform the n=2 RMPs with ΔΦ scan in L-mode plasmas
    - Perform the Nitrogen puffing without and with n=2 RMPs in L-mode plasmas
    - Repeat the last step in H-mode plasmas
  - Diagnostics: IR cameras, CXRS, TS, bolometer, divertor Langmuir probes, ECE, Reciprocating probes, visible imaging, coherence imaging diagnostic, …



Proposed pulses

Device	# Pulses/Session	# Development
AUG	5	
MAST-U	6	

#171: RMP effects on the access of detachment in super-x divertor and X-divertor configurations

- **Proponents and contact person:**

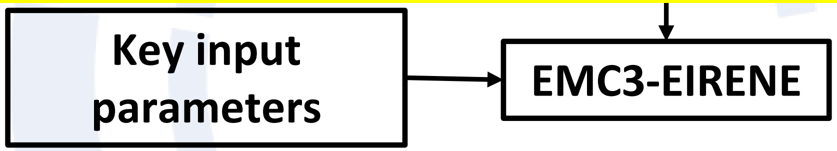
y.liang@fz-juelich.de

- **Scientific Background & Objectives**
  - Previous studies have found that RMPs has significant impacts on access detachment in traditional divertor configurations
  - Evaluating the effect of RMPs on detachment in super-X (MAST-U) and XD (ASD U) configurations
  - Investigating the influences of plasma response on divertor heat flux distributi under different RMP phases
  - Validating the MARS/EMC3-EIRENE modeling strategy by comparisons with experimental data
- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - On MAST-U with super-X divertor, focusing on n=1 RMPs with a phase of $\Delta\Phi = 0$
    - Perform density ramp-up with mid-plane puffing (or divertor puffing) without RMPs and with RMPs in H-mode plasmas
    - Perform divertor puffing without RMPs and with RMPs in H-mode plasmas
  - On ASDEX-U with X-divertor, focusing on the n=2 RMPs
    - Perform the n=2 RMPs with $\Delta\Phi$ scan in L-mode plasmas
    - Perform the Nitrogen puffing without and with n=2 RMPs in L-mode plasmas
    - Repeat the last step in H-mode plasmas
  - Diagnostics: IR cameras, CXRS, TS, bolometer, divertor Langmuir probes, ECE, Reciprocating probes, visible imaging, coherence imaging diagnostic, …

P2-AUG

P2-MAST-U

Relatively straightforward to be executed but RMPs are not within high-priority work under RT-07. However, we recognize that RMPs may help in scenario development on MAST-U



Proposed pulses

Device	# Pulses/Session	# Development
AUG	5	
MAST-U	6	

#145: Impact of the secondary X-point on the radial electric field in near SOL in SF- and super-CRD configurations

- **Proponents and contact person:**

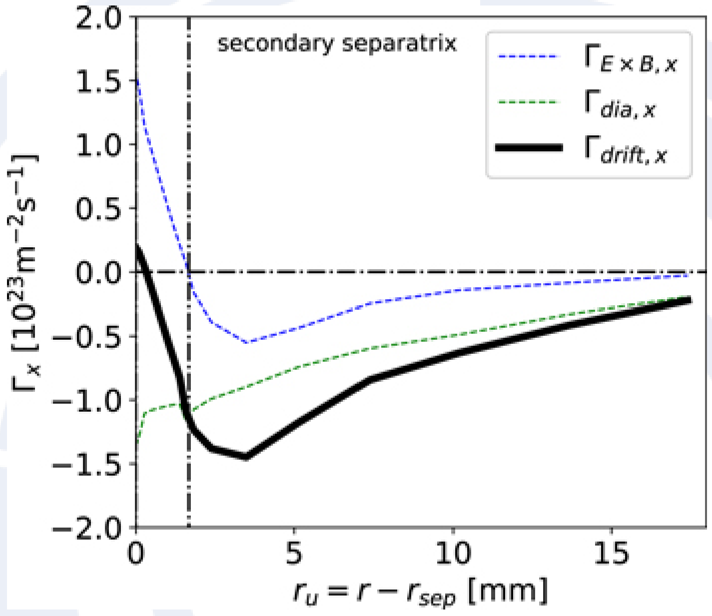
Ou Pan ou.pan@ipp.mpg.de, T. Lunt, B. Sieglin, D. Brida, G. Grenfell, X. Z. Liu, M. Faitsch, F. Albrecht, A. Kappatou, Y. C. Liang, R. Takacs, W. Fuller

- **Scientific Background & Objectives**

  The radial electric field in the near SOL provides important insights into SOL flows and serves as a critical boundary condition for the E_r shear layer. The presence of a secondary X-point in the SOL is expected to alter divertor profiles through geometric splitting effects or by modifying the radiation distribution in the divertor, such as through the formation of an X-point radiator at the primary or secondary X-points. Experiments on TCV [Tsui, et al., NF 2021] and SOLPS-ITER modeling for AUG [Pan, et al., PPCF 2020] have both demonstrated modifications, and in some cases even reversals, of E_r in the near SOL region in the snowflake-minus divertor. The AUG's new upper divertor offers the flexibility to reposition the secondary X-point within the SOL, providing a good testbed for studying the impact of the secondary X-point on near SOL E_r in ADCs, and for comparison with modeling results.

  – Measure the near-SOL E_r in snowflake-minus and super-CRD
  – Characterise the E_r profile with varying separation between the two separatrices
  – Analyse the change in E_r profile caused by radiation near the secondary X-point

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  – L-mode plasmas in LFS SF- divertor configuration with three steps of separation between the two separatrices. Measure near-SOL E_r profiles with MEM and DBS and compare results.
  – Repeat with increased fueling rate to achieve changes in divertor temperature.
  – Low-power H-mode discharges with three impurity seeding levels to modify divertor radiation and temperature conditions. Measure resulting changes of E_r profile with DBS
  – H-mode–like discharge in super-CRD configuration with two steps of separatrix distance. Measure corresponding changes of E_r profile.
  – Repeat in reversed B_t.
  – Diagnostic: MEM, DBS, CXRS, IR, TS, HEB, BOLO, LPs



[Pan et al., PPCF 2020]

Proposed pulses

Device	# Pulses/Session	# Development
AUG	7	

#145: Impact of the secondary X-point on the radial electric field in near SOL in SF- and super-CRD configurations

- **Proponents and contact person:**

Ou Pan ou.pan@ipp.mpg.de, T. Lunt, B. Sieglin, D. Brida, G. Grenfell, X. Z. Liu, M. Faitsch, F. Albrecht, A. Kappatou, Y. C. Liang, R. Takacs, W. Fuller

- **Scientific Background & Objectives**

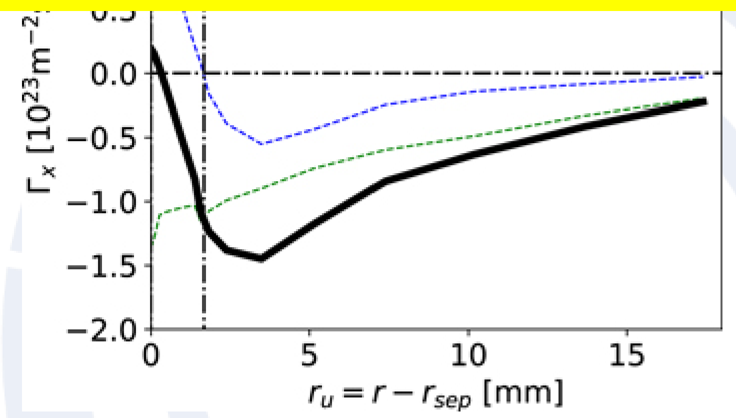
  The radial electric field in the near SOL provides important insights into SOL flows and serves as a critical boundary condition for the E_r shear layer. The presence of a secondary X-point in the SOL is expected to alter divertor profiles through geometric splitting effects or by modifying the radiation distribution in the divertor, such as through the formation of an X-point radiator at the primary or secondary X-points. Experiments on TCV [Tsui, et al., NF 2021] and SOLPS-ITER modeling for AUG [Pan, et al., PPCF 2020] have both demonstrated modifications, and in some cases even reversals, of E_r in the near SOL region in the snowflake-minus divertor. The AUG's new upper divertor offers the flexibility to reposition the secondary X-point within the SOL, providing a good testbed for studying the impact of the secondary X-point on near SOL E_r in ADCs, and for comparison with modeling results.

  - Measure the near-SOL E_r in snowflake-minus and super-CRD
  - Characterise the E_r profile with varying separation between the two separatrices
  - Analyse the change in E_r profile caused by radiation near the secondary X-point

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - L-mode plasmas in LFS SF- divertor configuration with three steps of separation between the two separatrices. Measure near-SOL E_r profiles with MEM and DBS and compare results.
  - Repeat with increased fueling rate to achieve changes in divertor temperature.
  - Low-power H-mode discharges with three impurity seeding levels to modify divertor radiation and temperature conditions. Measure resulting changes of E_r profile with DBS
  - H-mode–like discharge in super-CRD configuration with two steps of separatrix distance. Measure corresponding changes of E_r profile.
  - Repeat in reversed B_t.
  - Diagnostic: MEM, DBS, CXRS, IR, TS, HEB, BOLO, LPs

P2-AUG

Important physics topic, can be adopted on the agenda once other scans are completed



[Pan et al., PPCF 2020]

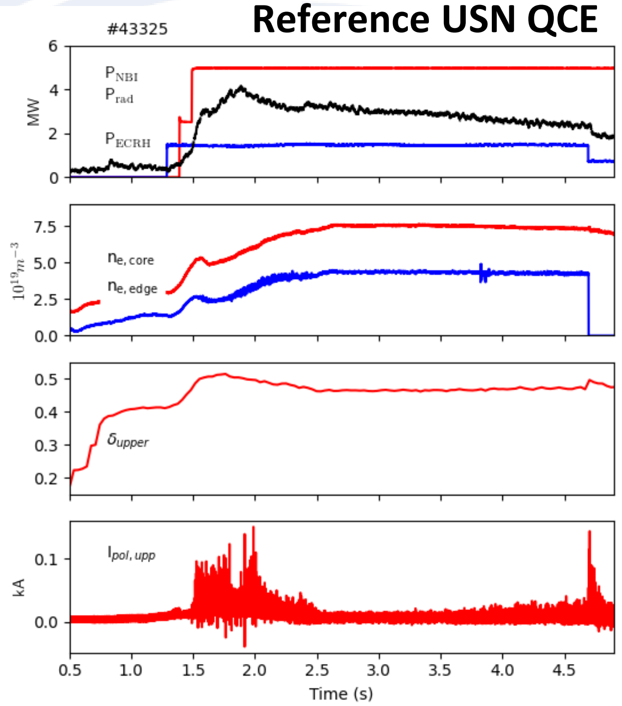
Proposed pulses

Device	# Pulses/Session	# Development
AUG	7	

#147: Interplay between X-point separation and power fall-off length

- **Proponents and contact person:**
  - Michael.Faitsch@ipp.mpg.de, Mike.Dunne@ipp.mpg.de
- **Scientific Background & Objectives**
  - Alternative divertor configurations use additional X-points to increase the wetted divertor area and increase the ability to radiate in the divertor volume. Especially the SF- divertor needs a well-balanced interplay between the location of the 2nd X-point and the power flowing in the SOL.
  - This optimisation challenge depends - among other quantities - on the distance of the 2nd X-point compared to the power fall-off length.
  - The QCE regime offers the unique capability to alter the power fall-off length by means of fueling.
- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - USN QCE discharge with
    - Varying separation of X-points
    - Fuelling scans at fixed X-point positions

Reference USN QCE



Proposed pulses

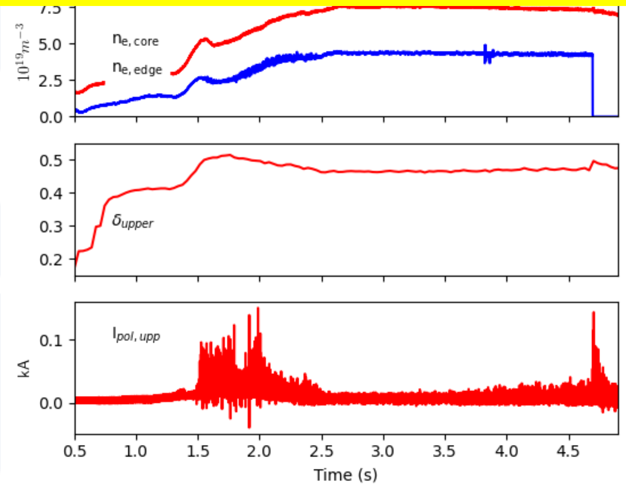
Device	# Pulses/Session	# Development
AUG	6	-

#147: Interplay between X-point separation and power fall-off length

- **Proponents and contact person:**
  - Michael.Faitsch@ipp.mpg.de, Mike.Dunne@ipp.mpg.de
- **Scientific Background & Objectives**
  - Alternative divertor configurations use additional X-points to increase the wetted divertor area and increase the ability to radiate in the divertor volume. Especially the SF- divertor needs a well-balanced interplay between the location of the 2nd X-point and the power flowing in the SOL.
  - This optimisation challenge depends - among other quantities - on the distance of the 2nd X-point compared to the power fall-off length.
  - The QCE regime offers the unique capability to alter the power fall-off length by means of fueling.
- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - USN QCE discharge with
    - Varying separation of X-points
    - Fuelling scans at fixed X-point positions

P1-AUG-2026

For us this is a low-hanging fruit and utilizes synergy between RT-07 and RT-02



Proposed pulses

Device	# Pulses/Session	# Development
AUG	6	-

#146: Far SOL transport and its interaction with W wall in ADCs

- **Proponents and contact person:**

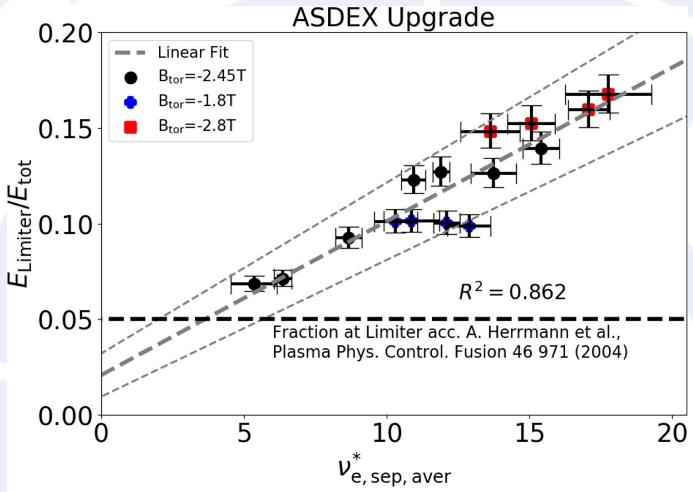
Ou Pan ou.pan@ipp.mpg.de, H. Wang, T. Lunt, B. Sieglin, D. Brida, M. Faitsch, S. Hörmann, G. Grenfell, F. Albrecht, A. Kappatou, H. Wu, M. Rabaldo, W. Fuller

- **Scientific Background & Objectives**

  The recent adoption of a tungsten first wall in ITER, together with the emergence of compact fusion concepts with reduced wall distance, underscores the urgency of reassessing critical issues such as far SOL transport, particle and heat loads on the wall, and tungsten sputtering and transport. Experiments and simulations show that detachment with ELM mitigation in a conventional divertor often requires higher separatrix densities and stronger radial transport, which in turn increase wall fluxes and complicate interactions. Thus, exploring ADCs for power exhaust must be closely linked with studies of far SOL transport and first wall interactions, highlighting the need for detailed diagnostics across different geometries and conditions.

  In XD, SF, and CRD divertor configurations under varying separatrix densities and detachment conditions:
  - Characterise far-SOL plasma parameters.
  - Quantify first-wall heat loads.
  - Assess core tungsten concentrations with different seeding impurities.
  - Collect comprehensive datasets to support integrated edge modeling.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - After fresh boronization, no impurity seeding: In the XD divertor configuration, apply two heating levels, each of which includes three fueling rate steps. Repeat the same sequence in the LFS SF- divertor configuration.
  - With Ar seeding: Conduct three discharges in each of the following configurations: XD, LFS SF-, and CRD.
  - With Ne seeding: Repeat the same experimental sequence as for Ar seeding; CRD optional.
  - Reference cases (as needed): Discharges with N seeding. Discharges in the SN divertor configuration.
  - Diagnostics: MEM, HEB, TS, IR, LPs, CXRS, BOLO, cooling water calorimetry



[Redl et al., NME 2023]

Proposed pulses

Device	# Pulses/Session	# Development
AUG	10	

#146: Far SOL transport and its interaction with W wall in ADCs

- **Proponents and contact person:**

Ou Pan ou.pan@ipp.mpg.de, H. Wang, T. Lunt, B. Sieglin, D. Brida, M. Faitsch, S. Hörmann, G Grenfell, F. Albrecht, A. Kappatou, H. Wu, M. Rabaldo, W. Fuller

P1-AUG-2026

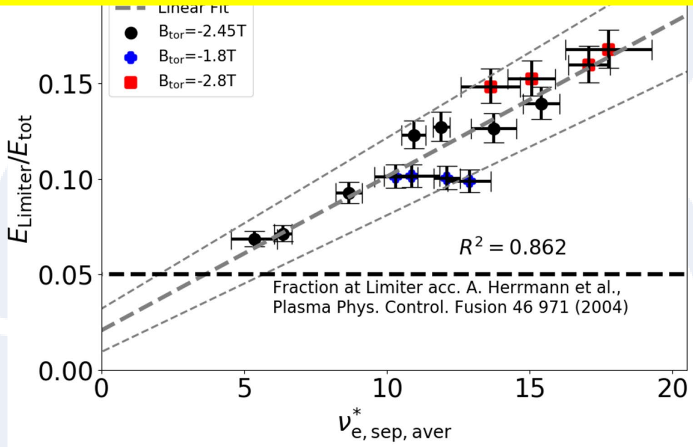
High-priority topic for ITER and ITPA DiVSOL

- **Scientific Background & Objectives**

  The recent adoption of a tungsten first wall in ITER, together with the emergence of compact fusion concepts with reduced wall distance, underscores the urgency of reassessing critical issues such as far SOL transport, particle and heat loads on the wall, and tungsten sputtering and transport. Experiments and simulations show that detachment with ELM mitigation in a conventional divertor often requires higher separatrix densities and stronger radial transport, which in turn increase wall fluxes and complicate interactions. Thus, exploring ADCs for power exhaust must be closely linked with studies of far SOL transport and first wall interactions, highlighting the need for detailed diagnostics across different geometries and conditions.

  In XD, SF, and CRD divertor configurations under varying separatrix densities and detachment conditions:
  - Characterise far-SOL plasma parameters.
  - Quantify first-wall heat loads.
  - Assess core tungsten concentrations with different seeding impurities.
  - Collect comprehensive datasets to support integrated edge modeling.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - After fresh boronization, no impurity seeding: In the XD divertor configuration, apply two heating levels, each of which includes three fueling rate steps. Repeat the same sequence in the LFS SF- divertor configuration.
  - With Ar seeding: Conduct three discharges in each of the following configurations: XD, LFS SF-, and CRD.
  - With Ne seeding: Repeat the same experimental sequence as for Ar seeding; CRD optional.
  - Reference cases (as needed): Discharges with N seeding. Discharges in the SN divertor configuration.
  - Diagnostics: MEM, HEB, TS, IR, LPs, CXRS, BOLO, cooling water calorimetry



[Redl et al., NME 2023]

Proposed pulses

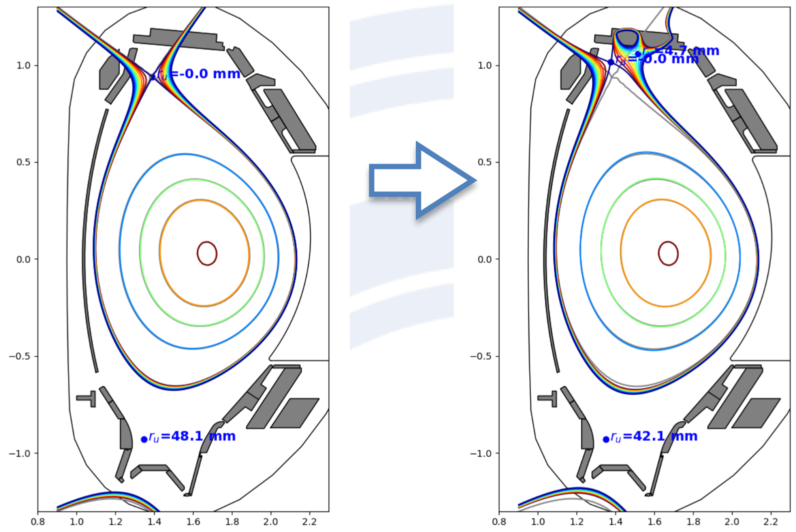
Device	# Pulses/Session	# Development
AUG	10	

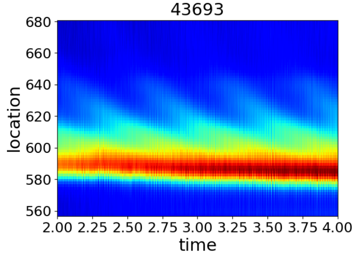
#141: Burn throughs in ADCs due to RMPs

- **Proponents and contact person:**
  matthias.willensdorfer@ipp.mpg.de

- **Scientific Background & Objectives**
  - Study the impact of perturbation on ADC and the detachment
  - Hydrogen plasma allows high P_{ECRH} and small density resulting in good IR data of L-mode plasmas
  - Combing rotation RMPs for simulating perturbations , new upper divertor and step-wise density ramps allows to study possible burn throughs due to perturbation at the detachment onset
  - **Analysis**
  - - Determine power load onto the divertor target
  - - Evaluated Detachment
  - - Comparisons to predictions and EMC3-Eirene are foreseen (by exchange student)

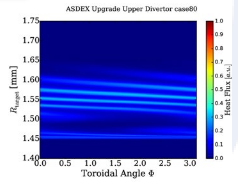
- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - First Measurements in new upper divertor with rotating RMPs in H have been done without ADC
  - Essential is Hydrogen plasma, LP, IR and ECRH are essential
  - Repeat of 43693 with ADC currents and step-wise density ramps, including their fine-scans





???

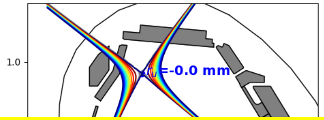
Predictions:
M. Faitsch

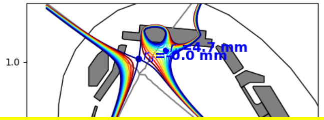


Proposed pulses

Device	# Pulses/Session	# Development
AUG	6	

#141: Burn throughs in ADCs due to RMPs



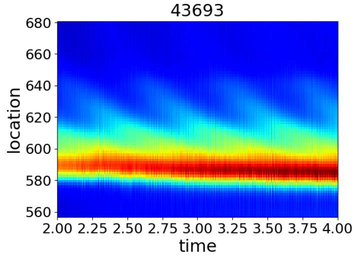


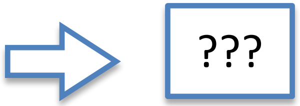
P2-AUG
We acknowledge the importance of the topic for ITPA investigations but this is a proposal only for the H phase of AUG – where it needs to be balanced against wishes from other RTs

- **Proponents and contact person:**
  matthias.willensdorfer@ipp.mpg.de

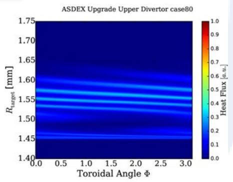
- **Scientific Background & Objectives**
  – Study the impact of perturbation on ADC and the detachment
  – Hydrogen plasma allows high P_{ECRH} and small density resulting in good IR data of L-mode plasmas
  – Combing rotation RMPs for simulating perturbations , new upper divertor and step-wise density ramps allows to study possible burn throughs due to perturbation at the detachment onset
  – **Analysis**
  – - Determine power load onto the divertor target
  – - Evaluated Detachment
  – - Comparisons to predictions and EMC3-Eirene are foreseen (by exchange student)

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  – First Measurements in new upper divertor with rotating RMPs in H have been done without ADC
  – Essential is Hydrogen plasma, LP, IR and ECRH are essential
  - Repeat of 43693 with ADC currents and step-wise density ramps, including their fine-scans





Predictions:
M. Faitsch



Proposed pulses

Device	# Pulses/Session	# Development
AUG	6	

#167: ELM-resolved upper divertor profiles from spectroscopic measurements in ADCs at AUG

- **Proponents and contact person:**
  - H. Lindl (Hannah.Lindl@ipp.mpg.de) et al.
- **Scientific Background & Objectives**

  With our upper divertor spectroscopic setup, we can measure radially resolved electron densities, electron and ion temperatures, drift velocities and impurity ion densities with a time resolution down to 2.4 ms. By measuring at low ELM repetition frequencies (vELM ~100 Hz), we want to obtain multiple measurement points in the inter-ELM phase and thereby gain information about inter-ELM transport, impurity behavior, and the detachment onset in ADCs at AUG.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - X-Divertor configuration at Ip=1MA, Bt = 2.5T, high triangularity
  - Sweep of Pheat (NBI/ECRH) to find minimum ELM repetition frequency at tolerable heat loads (1# + 2# backup)
  - Scan of N seeding/D fueling to observe attachment-detachment transition spectroscopically (1# + 1# backup)
  - Repetition in conventional USN configuration to study impact of flux expansion (1# + 1# backup)
  - Repeated measurements of higher ionization nitrogen lines to determine seeding impurity ion density (4# + 1#backup)
  - Essential diagnostics: Upper divertor spectroscopy, Langmuir probes, Thomson scattering, bolometry

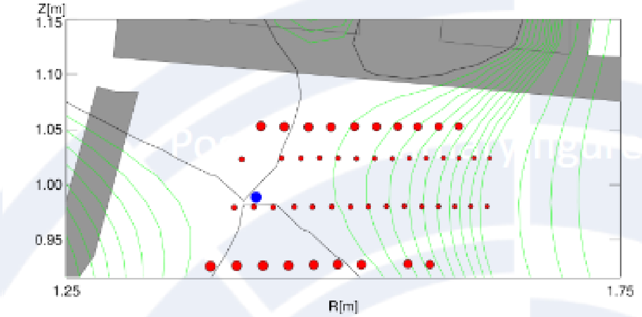


Fig. 1: Spectrometer measurement positions in the upper divertor volume.

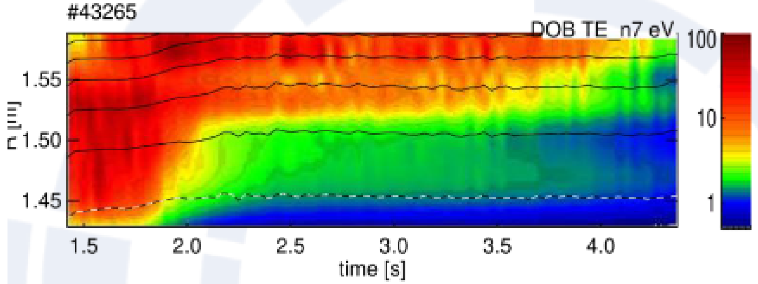


Fig. 2: Exemplary Te profile and time evolution of a N scan. The detachment onset can be seen around 2s. The separatrix position is indicated by the dashed line.

Proposed pulses

Device	# Pulses/Session	# Development
AUG	12	6

#167: ELM-resolved upper divertor profiles from spectroscopic measurements in ADCs at AUG

- **Proponents and contact person:**
  - H. Lindl (Hannah.Lindl@ipp.mpg.de) et al.
- **Scientific Background & Objectives**

  With our upper divertor spectroscopic setup, we can measure radially resolved electron densities, electron and ion temperatures, drift velocities and impurity ion densities with a time resolution down to 2.4 ms. By measuring at low ELM repetition frequencies (vELM ~100 Hz), we want to obtain multiple measurement points in the inter-ELM phase and thereby gain information about inter-ELM transport, impurity behavior, and the detachment onset in ADCs at AUG.

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  - Repeated measurements of higher ionization nitrogen lines to determine seeding impurity ion density (4# + 1#backup)
  - Essential diagnostics: Upper divertor spectroscopy, Langmuir probes, Thomson scattering, bolometry

P1-AUG-2027

The proposal utilizes a new diagnostics and would provide valuable data, to be scheduled after the P1-2026 proposals

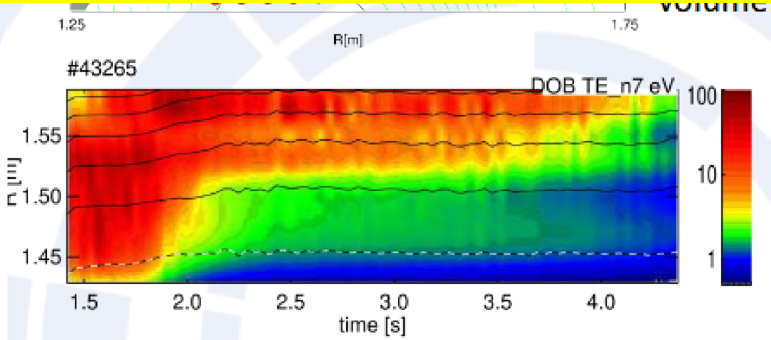


Fig. 2: Exemplary Te profile and time evolution of a N scan. The detachment onset can be seen around 2s. The separatrix position is indicated by the dashed line.

Proposed pulses

Device	# Pulses/Session	# Development
AUG	12	6

#170: Scrape-off layer fluctuation measurements in ADCs at AUG

Proponents and contact person:

William Fuller (william.fuller@ipp.mpg.de), F. Albrecht, D. Brida, G. Grenfell, M. Griener, S. Hörmann, X. Liu, T. Lunt

- **Scientific Background**
  1. Steep radial profiles and transport suppression necessary to sustain H-mode [Redl, et al., NF 2024]
  2. Collisionality and particle flux are instrumental in quantifying transport [Carralero, et al., NF 2017]
  3. Fluctuations in SOL can indicate turbulent mechanisms present [Bielajew, et al., NF 2023]

- **Objectives**

  Partly Addresses D1 (characterise plasma exhaust ADCs), D2 (characterise SF), strongly addresses D4 (validate core-edge models with ADC experiments). Determining relationship between ADCs and fluctuations in the SOL.

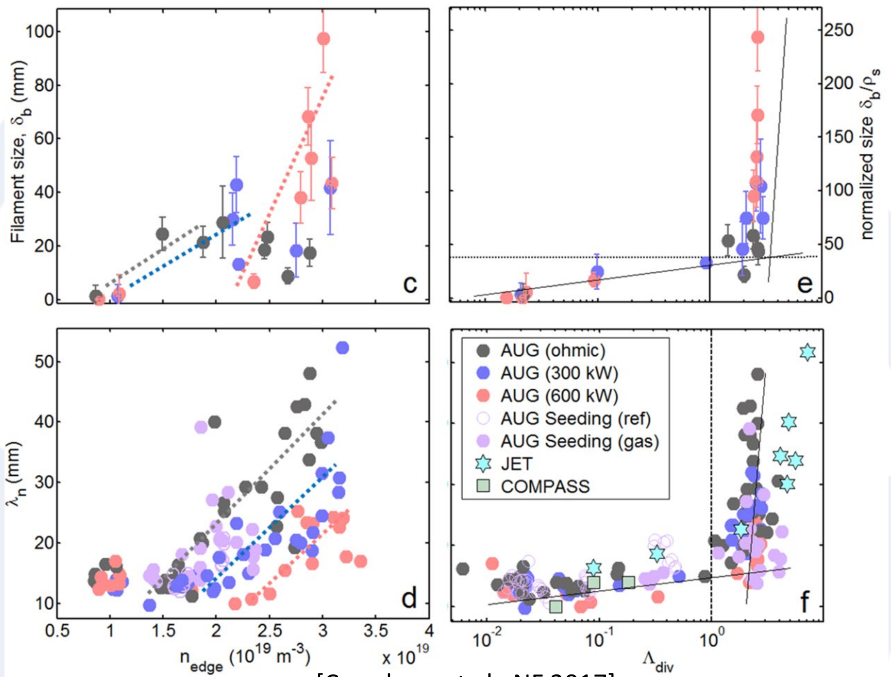
  •Measure fluctuating profiles across the SOL with multiple diagnostics.

  •Take measurements for ADC regimes in the AUG LSN.

  •Assess relation between fluctuations and transport processes for each ADC.

  •Add the ADC data to existing databases for turbulence models such as GRILLIX, SOLPS-ITER.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Sweep divertor shape across several ADCs at two densities.
  - **Diagnostics:** MEM, XPM, DBS, THB, lower divertor LPs



[Carralero, et al., NF 2017]

Proposed pulses

Device	# Pulses/Session	# Development
AUG	6	0

#170: Scrape-off layer fluctuation measurements in ADCs at AUG

Proponents and contact person:
William Fuller (william.fuller@ipp.mpg.de), F. Albrecht, D. Brida, G. Grenfell, M. Griener, S. Hörmann, X. Liu, T. Lunt

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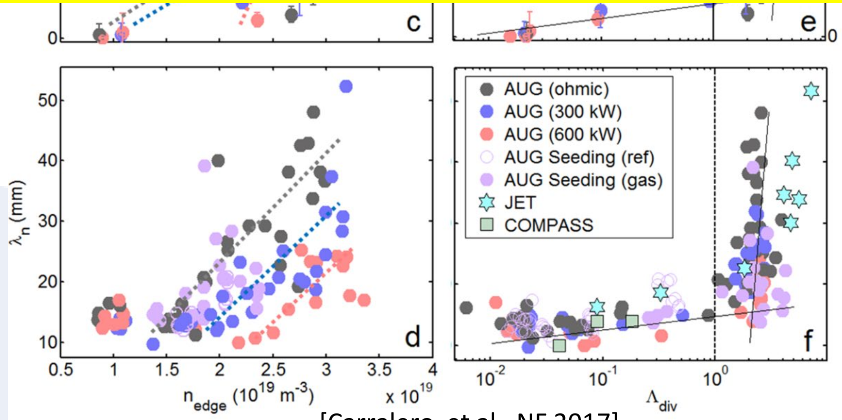
  - **Diagnostics:** MEM, XPM, DBS, THB, lower divertor LPs

P1-AUG-2026
Fluctuation measurements required for model validation, not only SOLPS-ITER but also GRILLIX



[Carralero, et al., NF 2017]

Proposed pulses

Device	# Pulses/Session	# Development
AUG	6	0

TCV specific proposals – including TBLLD

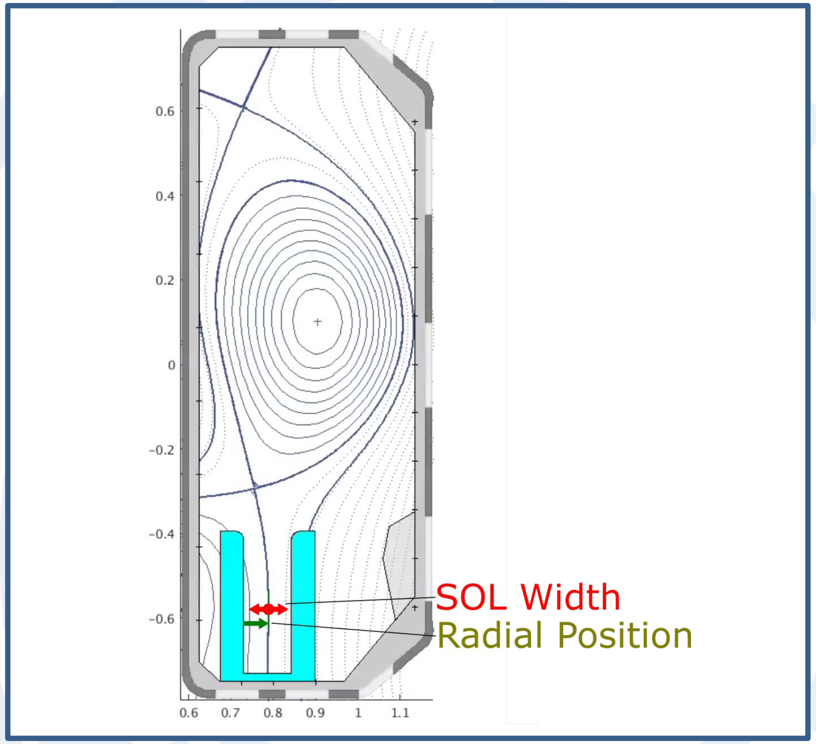
#154: Optimizing Plasma Plugging in a Tightly-Baffled Long-Legged Divertor

- **Proponents and contact person:**

Benjamin Brown (Benjamin.brown@epfl.ch), Olivier Février, Holger Reimerdes, Christian Theiler, Richard Ducker, Kenneth Lee, Pierre Sintre, Elena Tonello

- **Scientific Background & Objectives**
  - Elevated neutral pressure in the TBLLD is maintained through plasma plugging of the divertor entrance.
  - The influence of SOL plasma shaping on the effectiveness of plasma plugging will be investigated experimentally.
  - The performance of the optimized TBLLD scenario will be assessed.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - TCV with TBLLD, D_2 Ohmic L-mode plasmas
  - Scanning flux expansion, radial position and density
  - Essential Diagnostics
    - APGs, DSS, IR, MANTIS, RDPA, LPs, STCs



Proposed pulses

Device	# Pulses/Session	# Development
TCV	40	10

#154: Optimizing Plasma Plugging in a Tightly-Baffled Long-Legged Divertor

- **Proponents and contact person:**

Benjamin Brown (Benjamin.brown@epfl.ch), Olivier Février, Holger Reimerdes, Christian Theiler, Richard Ducker, Kenneth Lee, Pierre Sintre, Elena Tonello

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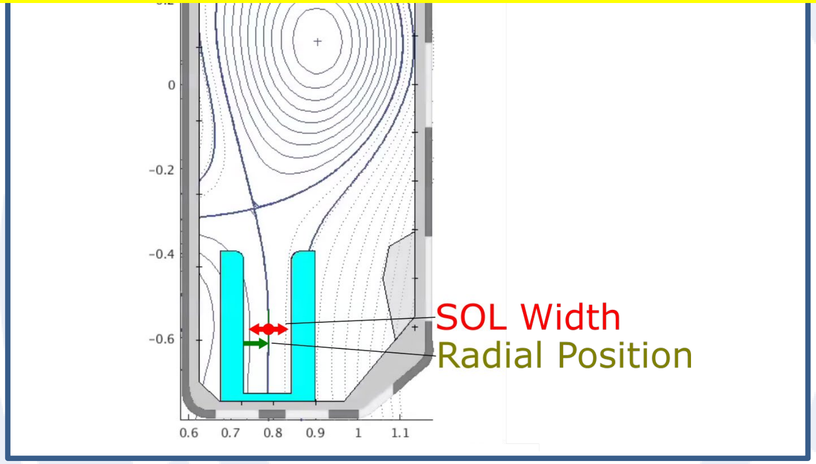
  - TCV with TBLLD, D_2 Ohmic L-mode plasmas
  - Scanning flux expansion, radial position and density
  - Essential Diagnostics
    - APGs, DSS, IR, MANTIS, RDPA, LPs, STCs

P1-TCV-2026
TBLLD scenario work and different scans in L-mode. Support but reduced number of discharges.



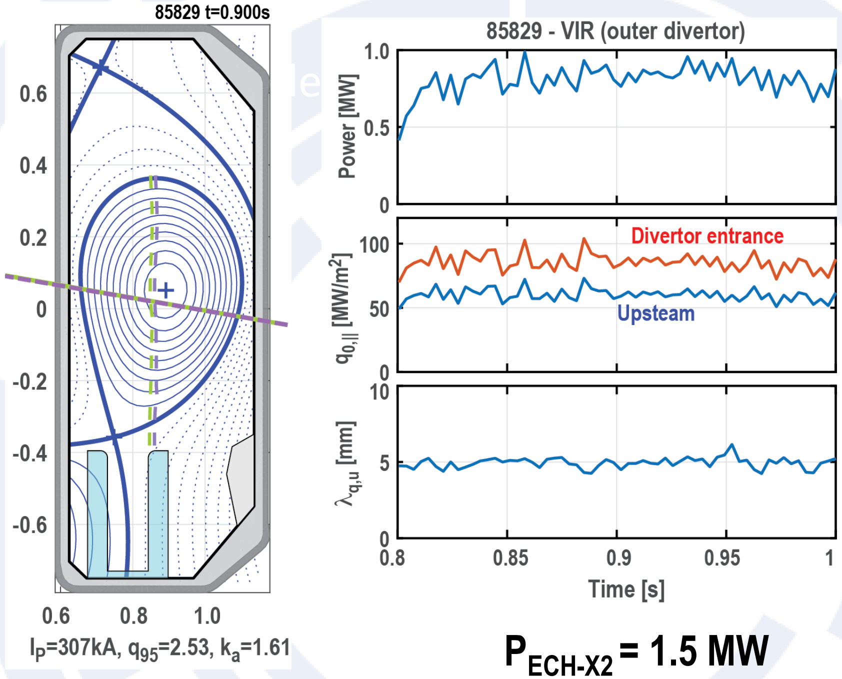
Proposed pulses

Device	# Pulses/Session	# Development
TCV	40	10

#156: High power dissipation in TCV's Tightly-Baffled, Long-Legged Divertor (TBLLD)

- **Proponents and contact person:**
  holger.reimerdes@epfl.ch, benjamin.brown@epfl.ch, olivier.fevrier@epfl.ch, kieran.murray@ukaea.uk, pierre.sintre@epfl.ch, christian.theiler@epfl.ch, k.h.a.verhaegh@tue.nl, martim.zurita@epfl.ch
- **Scientific Background & Objectives**
  - TBLLD designed for high heat flux mitigation → challenge concept with highest heat fluxes: $q_{||} > 100\ \mathrm{MW/m^2}$ (at lowest densities)
  - Measure target and divertor parameters to validate edge models; evaluate ELM buffering
- **Experimental Strategy/Machine Constraints and essential diagnostic**
  1. Choose reference configuration (outer SP radius and flux expansion) from "TBLLD optimisation" experiment
  2. Add **NBI** with various power levels ranging from 0.5MW to 2.5MW with slow (quasi-static) ramps **10 shots**
  3. Add **ECH** with various power levels ranging from 0.5M to 2.6MW with slow (quasi-static) ramps **10 shots**
  4. If thermo-electric currents are not observed, increase **in-out asymmetry**, e.g. through higher flux expansion **5 shots**
  5. Select most severe exhaust scenario and **seed impurities** (N_2, Ne) **10 shots**
  6. Select stationary **ELM**y H-mode from step 2 and **seed impurities** **5 shots**

High $q_{||}$ scenarios



$P_{ECH\text{-}X2}$ = 1.5 MW

Proposed pulses

Device	# Pulses/Session	# Development
TCV	40	

#156: High power dissipation in TCV's Tightly-Baffled, Long-Legged Divertor (TBLLD)

P1-TCV-2026

TBLLD scenario work and different scans in H-mode. WPTE highest priority among the TBLLD proposals.

- **Proponents and contact person:**

holger.reimerdes@epfl.ch, benjamin.brown@epfl.ch, olivier.fevrier@epfl.ch, kieran.murray@ukaea.uk, pierre.sintre@epfl.ch, christian.theiler@epfl.ch, k.h.a.verhaegh@tue.nl, martim.zurita@epfl.ch

- **Scientific Background & Objectives**
  - TBLLD designed for high heat flux mitigation → challenge concept with highest heat fluxes: $q_{||} > 100\ \mathrm{MW/m^2}$ (at lowest densities)
  - Measure target and divertor parameters to validate edge models; evaluate ELM buffering

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  1. Choose reference configuration (outer SP radius and flux expansion) from "TBLLD optimisation" experiment
  2. Add **NBI** with various power levels ranging from 0.5MW to 2.5MW with slow (quasi-static) ramps **10 shots**
  3. Add **ECH** with various power levels ranging from 0.5M to 2.6MW with slow (quasi-static) ramps **10 shots**
  4. If thermo-electric currents are not observed, increase **in-out asymmetry**, e.g. through higher flux expansion **5 shots**
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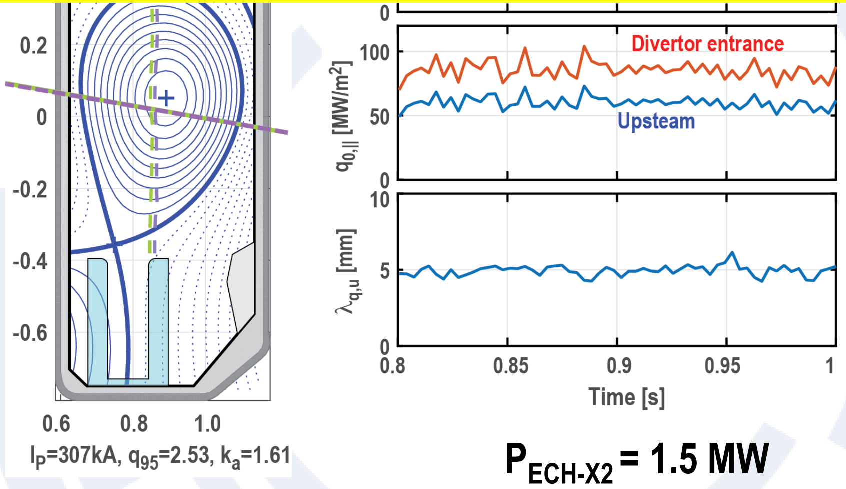
  6. Select stationary **ELM**y H-mode from step 2 and **seed impurities** **5 shots**



Proposed pulses

Device	# Pulses/Session	# Development
TCV	40	

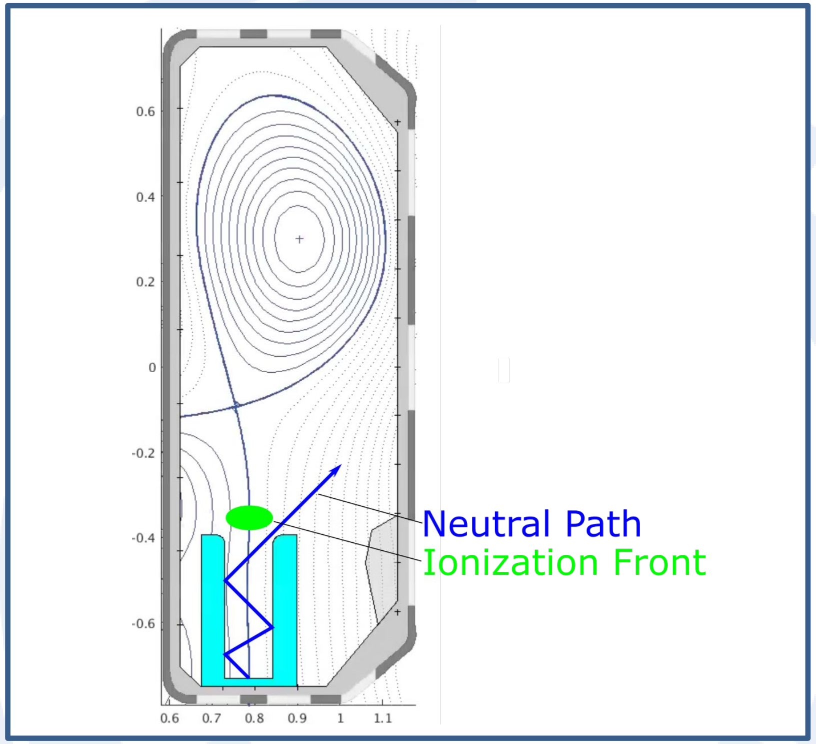
#155: Detachment Front Evolution in a Chimney-like Configuration

- **Proponents and contact person:**

Benjamin Brown (Benjamin.brown@epfl.ch), Olivier Février, Holger Reimerdes, Christian Theiler, Pierre Sintre, Elena Tonello

- **Scientific Background & Objectives**
  - The power exhaust improvements in the TBLLD are expected due to elevated divertor neutral pressures
  - The elevated neutral pressures are maintained through plasma plugging of the divertor entrance
  - Should the ionization front exit the TBLLD, the plasma plugging will be diminished leading to a reduction in divertor neutral pressure
  - This feedback loop may provide passive stability of the ionization front just above the TBLLD entrance, to be studied here.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - TCV with TBLLD, D_2 Ohmic L-mode Plasmas, Long Leg Configuration
  - Essential Diagnostics
    - APGs, DSS, MANTIS



Proposed pulses

Device	# Pulses/Session	# Development
TCV	15	5

#155: Detachment Front Evolution in a Chimney-like Configuration

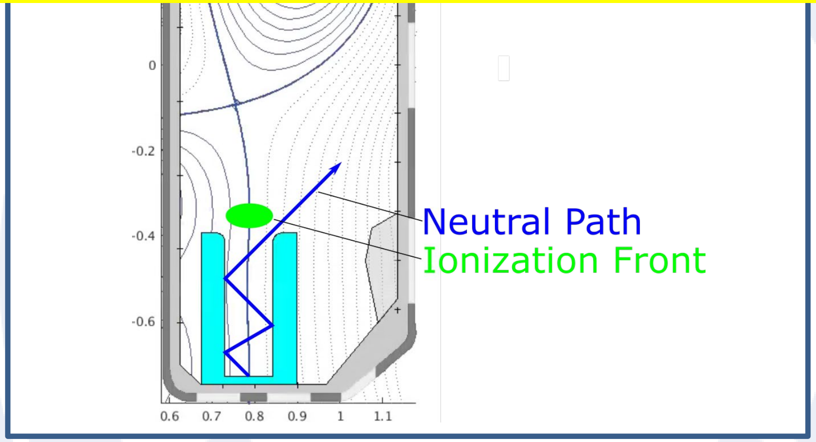
- **Proponents and contact person:**

Benjamin Brown (Benjamin.brown@epfl.ch), Olivier Février, Holger Reimerdes, Christian Theiler, Pierre Sintre, Elena Tonello

- **Scientific Background & Objectives**
  - The power exhaust improvements in the TBLLD are expected due to elevated divertor neutral pressures
  - The elevated neutral pressures are maintained through plasma plugging of the divertor entrance
  - Should the ionization front exit the TBLLD, the plasma plugging will be diminished leading to a reduction in divertor neutral pressure
  - This feedback loop may provide passive stability of the ionization front just above the TBLLD entrance, to be studied here.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - TCV with TBLLD, D_2 Ohmic L-mode Plasmas, Long Leg Configuration
  - Essential Diagnostics
    - APGs, DSS, MANTIS

P2-TCV
More advanced studies in TBLLD, to be initiated once all the other pieces of work are completed



Proposed pulses

Device	# Pulses/Session	# Development
TCV	15	5

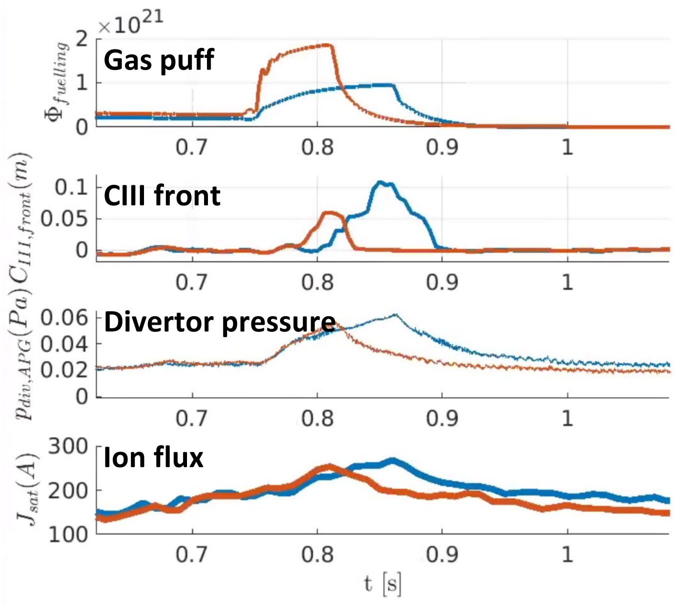
#164: Power and fuelling transients in the TBLLD

- **Proponents and contact person:**

Olivier Février (olivier.fevrier@epfl.ch), Benjamin Brown, Holger Reimerdes, Christian Theiler

- **Scientific Background & Objectives**
  - Assess the TBLLD ability to buffer transient power and fueling loads compared to a standard divertor.
    - ➢ Considered transients are fueling ramps at different rates, power steps, fueling steps. ELMs will be considered in other proposals.
  - Measure the response timescale of key detachment indicators (target temperature, neutral pressure, particle flux, etc.), possibly compare with SPLEND1D simulations.
  - The difference in transient behavior for a discharge with the ionization front above and below the entrance of the TBLLD will also be evaluated to isolate the possible effect of plasma plugging of the TBLLD on transient behavior
  - This proposal will inform other proposal on the timescales involved in the TBLLD and will help determine if measurements can be considered steady-state, which is often crucial for the interpretation.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - TCV with TBLLD, D_2 Ohmic L-mode Plasmas (at first). Standard configuration.
    - ➢ Density ramps, in TBLLD compatible configurations, at various ramp-rate. References discharges without TBLLD will also be useful.
    - ➢ Power transients in form of ramps (ECRH or NBH) and step-functions (ECRH or NBH)
    - ➢ Fueling transients in form of feed-forward step-functions. Fueling will either be performed from within the TBLLD, or from the main chamber.
  - Essential Diagnostics
    - ➢ APGs, DSS, MANTIS, STC, LP
  - Heating
    - ➢ NBH / ECRH



Proposed pulses

Device	# Pulses/Session	# Development
TCV	15	5

#164: Power and fuelling transients in the TBLLD

- **Proponents and contact person:**

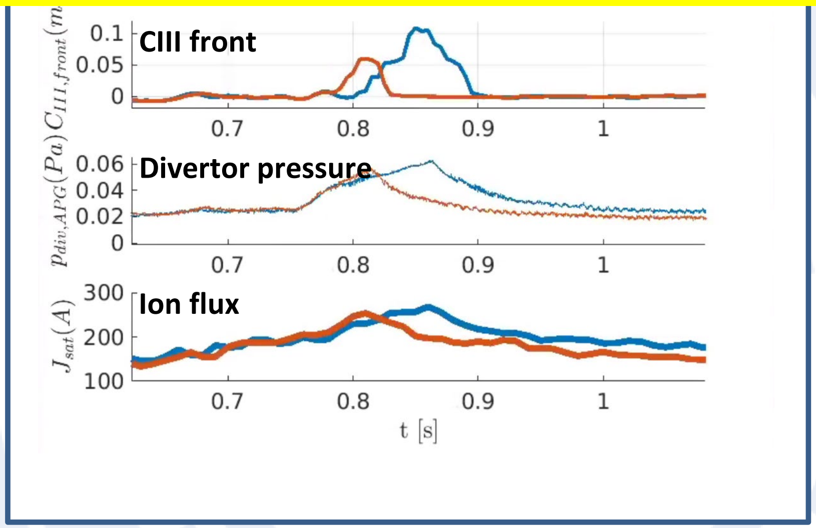
Olivier Février (olivier.fevrier@epfl.ch), Benjamin Brown, Holger Reimerdes, Christian Theiler

- **Scientific Background & Objectives**
  - Assess the TBLLD ability to buffer transient power and fueling loads compared to a standard divertor.
    - ➢ Considered transients are fueling ramps at different rates, power steps, fueling steps. ELMs will be considered in other proposals.
  - Measure the response timescale of key detachment indicators (target temperature, neutral pressure, particle flux, etc.), possibly compare with SPLEND1D simulations.
  - The difference in transient behavior for a discharge with the ionization front above and below the entrance of the TBLLD will also be evaluated to isolate the possible effect of plasma plugging of the TBLLD on transient behavior
  - This proposal will inform other proposal on the timescales involved in the TBLLD and will help determine if measurements can be considered steady-state, which is often crucial for the interpretation.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - TCV with TBLLD, D_2 Ohmic L-mode Plasmas (at first). Standard configuration.
    - ➢ Density ramps, in TBLLD compatible configurations, at various ramp-rate. References discharges without TBLLD will also be useful.
    - ➢ Power transients in form of ramps (ECRH or NBH) and step-functions (ECRH or NBH)
    - ➢ Fueling transients in form of feed-forward step-functions. Fueling will either be performed from within the TBLLD, or from the main chamber.
  - Essential Diagnostics
    - ➢ APGs, DSS, MANTIS, STC, LP
  - Heating
    - ➢ NBH / ECRH

P1-TCV-2026

Transient studies also included in the key objectives of WPTE.



Proposed pulses

Device	# Pulses/Session	# Development
TCV	15	5

#173: Characterisation of turbulence and transport in the TBLLD

- **Proponents and contact person:**
Christian Theiler et al. | christian.theiler@epfl.ch

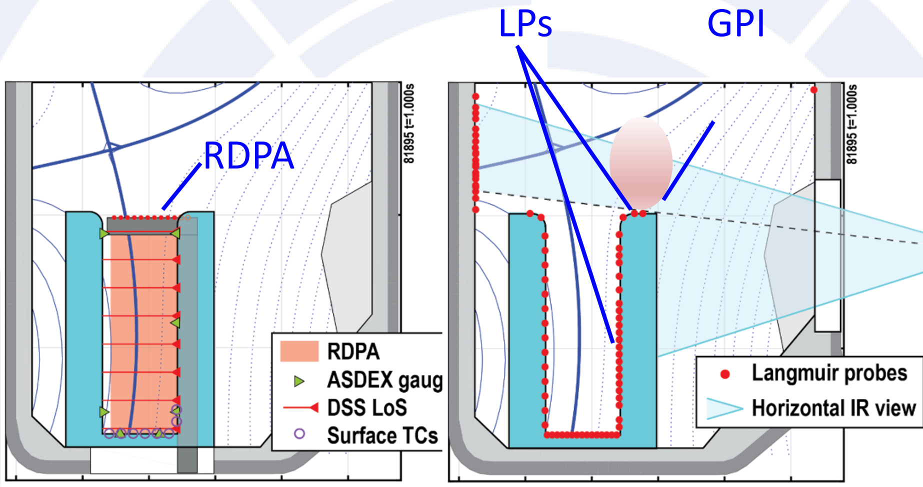
- **Scientific Background**
  - SOLPS-ITER predicts an order-of-magnitude improvement in power exhaust for the Tightly Baffled, Long-Legged Divertor (TBLLD), yet relying on a simplified description of turbulence-induced transport
  - The role of turbulence in the TBLLD is difficult to predict. In particular, high levels of recycling at the outer sidewall of the TBLLD may play an important role in its performance, but remain poorly understood (see Umansky et al., NF 2017)

- **Scientific Objectives**
  Assess the effect of turbulence and related transport in the TBLLD on:
  - upstream density shoulder and first-wall interaction
  - plasma-wall interaction at the baffle entrance
  - transport towards the outer sidewall of the TBLLD and related recycling effects

  Simulate and interpret the results with the GBS turbulence code

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  TCV
  - Cover attached and detachment conditions in L- and H-mode (QCE), scanning divertor gas puffing
  - Use full diagnostic suite, including fluctuation diagnostics at the midplane, the TBLLD entrance and inside the TBLLD (see figure at right)

Outboard midplane fluctuation diagnostics : GPI, outer-wall LPs, future fast-reciprocating probe



[Reimerdes et al., IAEA-FEC 2025]

Proposed pulses

Device	# Pulses/Session	# Development
TCV	16	0

#173: Characterisation of turbulence and transport in the TBLLD

- **Proponents and contact person:**

Christian Theiler et al. | christian.theiler@epfl.ch

- **Scientific Background**
  - SOLPS-ITER predicts an order-of-magnitude improvement in power exhaust for the Tightly Baffled, Long-Legged Divertor (TBLLD), yet relying on a simplified description of turbulence-induced transport
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 Simulate and interpret the results with the GBS turbulence code

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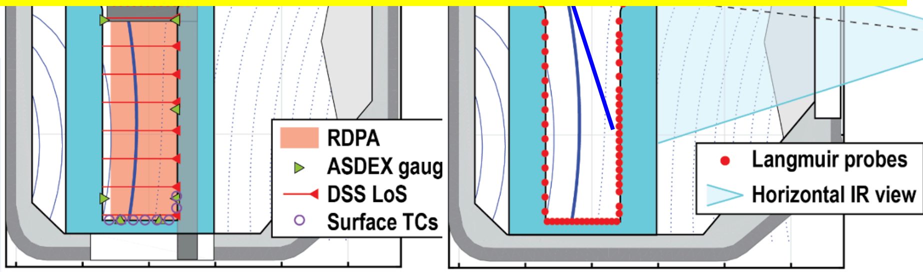
 <u>**TCV**</u>
  - Cover attached and detachment conditions in L- and H-mode (QCE), scanning divertor gas puffing
  - Use full diagnostic suite, including fluctuation diagnostics at the midplane, the TBLLD entrance and inside the TBLLD (see figure at right)

P1-TCV-2026 / PB

Turbulence measurements in TBLLD configuration can be included in the program, however, shot plan to be elaborated and part of the studies considered PB



[Reimerdes et al., IAEA-FEC 2025]

Proposed pulses

Device	# Pulses/Session	# Development
TCV	16	0

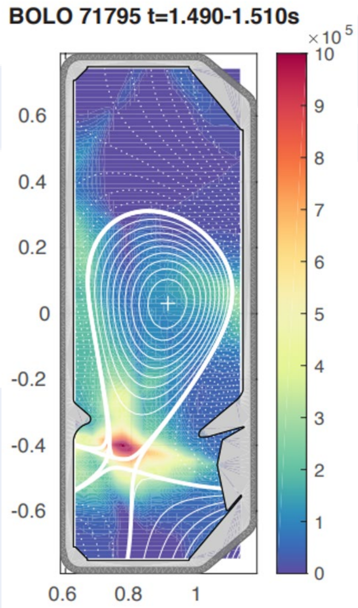
#153: Characterization of turbulence in X-point radiator H-mode scenarios on TCV

- **Proponents and contact person:**

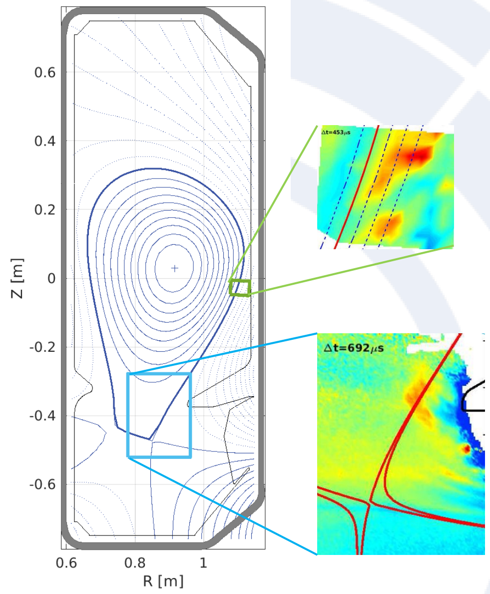
Yinghan Wang (yinghan.wang@epfl.ch), M. Agostini, M. Bernert, M. Czarski, O. Février, M. Griener, M. Herschel, A. Khan, M. La Matina, H. Reimerdes, K. Singh, C. Theiler, M. Ugoletti

- **Scientific Background & Objectives**
  - **[Background]** The X-point radiator (XPR) regime in H-mode shows potential to combine high confinement with a detached divertor, which is critical for future tokamaks. Turbulence mechanism in this regime still requires exploration.
  - **[Main objective]**
    - Study the turbulence behavior
      - in single null and snowflake XPR in TCV
      - in different locations (midplane, X-point)
      - during the ELM suppression phase in the XPR regime, comparing with the ELMy phase.
    - Investigate the previous points as a function of fueling and seeding.
    - Study the particle transport in the XPR regime.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - **H-mode XPR, NBI, possible ECRH** power for XPR stability
  - **Comparison with L-mode plasma** in SN and SF geometry
  - **midplane and X-point GPI systems** (SISO or SILO baffle, LFS and HFS)
  - **LPs, MANTIS, bolometry**: to monitor detachment and XPR
  - **High-speed camera**: wide field passive imaging
  - Combining with the **THB, Wall LP and RDPA** to study the particle flux during the ELM free phase.
  - Support with SOLPS-ITER XPR simulations + possibly turbulence codes



[H. Reimerdes et al. 2024 NME]



GPI fields of view

Proposed pulses

Device	# Pulses/Session	# Development
TCV	12	0

#153: Characterization of turbulence in X-point radiator H-mode scenarios on TCV

- **Proponents and contact person:**

Yinghan Wang (yinghan.wang@epfl.ch), M. Agostini, M. Bernert, M. Czarski, O. Février, M. Griener, M. Herschel, A. Khan, M. La Matina, H. Reimerdes, K. Singh, C. Theiler, M. Ugoletti

P1-TCV-2027 / PB

To be executed after the TBLLD phase, also here consider doing work PB or under the internal campaign

- **Scientific Background & Objectives**
  - **[Background]** The X-point radiator (XPR) regime in H-mode shows potential to combine high confinement with a detached divertor, which is critical for future tokamaks. Turbulence mechanism in this regime still requires exploration.
  - **[Main objective]**
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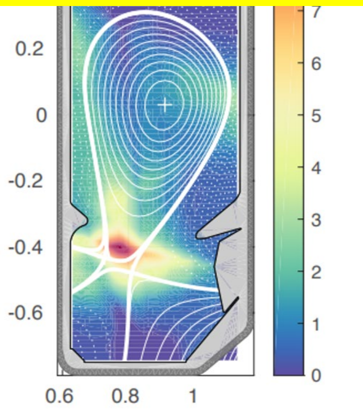
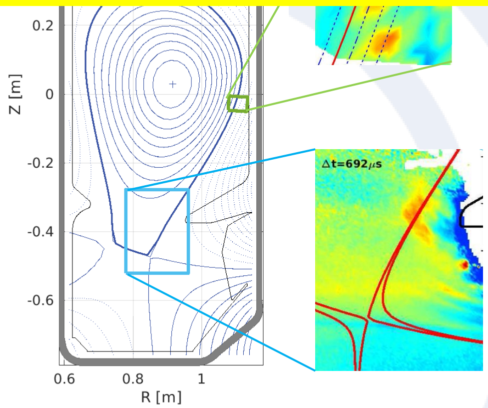
    - Investigate the previous points as a function of fueling and seeding.
    - Study the particle transport in the XPR regime.



[H. Reimerdes et al. 2024 NME]



GPI fields of view

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - **H-mode XPR, NBI, possible ECRH** power for XPR stability
  - **Comparison with L-mode plasma** in SN and SF geometry
  - **midplane and X-point GPI systems** (SISO or SILO baffle, LFS and HFS)
  - **LPs, MANTIS, bolometry**: to monitor detachment and XPR
  - **High-speed camera**: wide field passive imaging
  - Combining with the **THB, Wall LP and RDPA** to study the particle flux during the ELM free phase.
  - Support with SOLPS-ITER XPR simulations + possibly turbulence codes

Proposed pulses

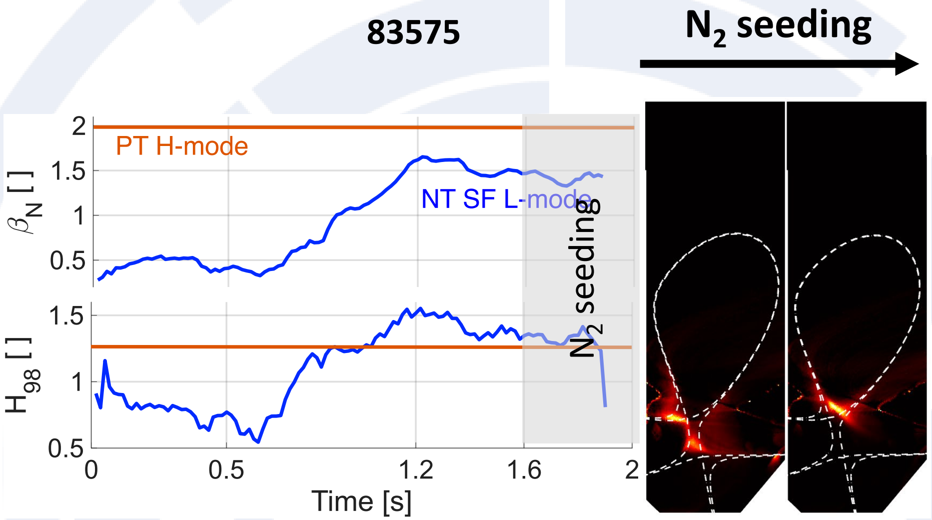
Device	# Pulses/Session	# Development
TCV	12	0

#157: Detachment in TCV high-power NT scenarios leveraging ADCs

- **Proponents and contact person:**
  - G. Durr-Legoupil-Nicoud garance.durr-legoupil-nicoud@epfl.ch
  - O. Février, H. Reimerdes, C. Theiler

- **Scientific Background & Objectives**

  Negative triangularity (NT) may bring H-mode grade confinement in L-Mode operation, making it an attractive solution for a reactor.
  Snowflake (SF) has demonstrated easier access to detachment more accessible in NT, and, surprisingly better core performances than standard LSN. [Durr-Legoupil-Nicoud'EPS25]
  This proposal aims to assess how coupling ADCs in high-power NT scenarios on TCV affect detachment acess and window
  → Continue developing and characterizing a high-performance high-power NBI-heated NT L-mode scenario with a SF divertor and add ECRH to evolve to a reactor-relevant scenario
  → Extend the SF detachment using N_2 injection at various degrees of power and different ADCs (XD, XPT, TBLLD).
  → Investigate the nitrogen penetration in the core and thus core-edge compatibility at these different levels of power and with the different ADCs



[Durr-Legoupil-Nicoud'EPS25]

Can ADCs allow to obtain a detached NT L-mode with H-mode PT performances on TCV?

Proposed pulses

Device	# Pulses/Session	# Development
TCV	30	20

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - N_2 seeding ramps with NBI/ECRH in NT-ADC plasma: multiple input power levels, N_2 seeding at different rates
  - Detached NT L-mode with NBH and or/ECRH with ADCs: preferably no baffles (except for TBLLD)
  - Essential diagnostics: edge diagnostics (IR,LP,RDPA,GPI) and CXRS

#157: Detachment in TCV high-power NT scenarios leveraging ADCs

- **Proponents and contact person:**
  - G. Durr-Legoupil-Nicoud garance.durr-legoupil-nicoud@epfl.ch
  - O. Février, H. Reimerdes, C. Theiler

- **Scientific Background & Objectives**

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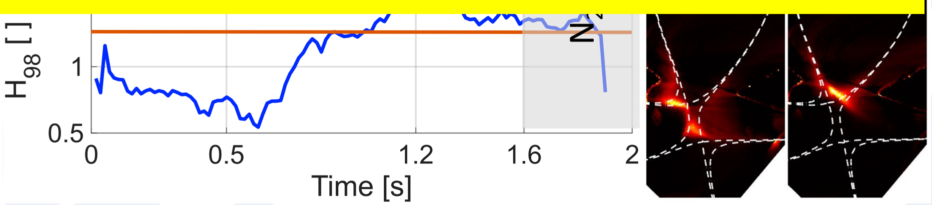
→ Investigate the nitrogen penetration in the core and thus core-edge compatibility at these different levels of power and with the different ADCs

P1-TCV-2027
Continuation of the promising work initiated in 2025. Requirements for the baffle configuration to be further discussed which would affect the 2026/2027 scheduling and number of shots allocated.



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  - Detached NT L-mode with NBH and or/ECRH with ADCs: preferably no baffles (except for TBLLD)
  - Essential diagnostics: edge diagnostics (IR,LP,RDPA,GPI) and CXRS

Proposed pulses

Device	# Pulses/Session	# Development
TCV	30	20

#168: Investigation of the impact of secondary X-point radial distance from the separatrix on the X-point target performance

- **Proponents and contact person:**

Massimo Carpita | massimo.carpita@epfl.ch

- **Scientific Background**
  - XPT has been shown to greatly reduce target temperature and heat fluxes compared to LSN, in different plasma scenarios
  - Recent SOLPS-ITER modelling shows a large sensitivity of the results to the secondary X-point separation in radial space (dru_XP2, mapped upstream), due to ExB-driven redistribution of particles around the secondary X-point

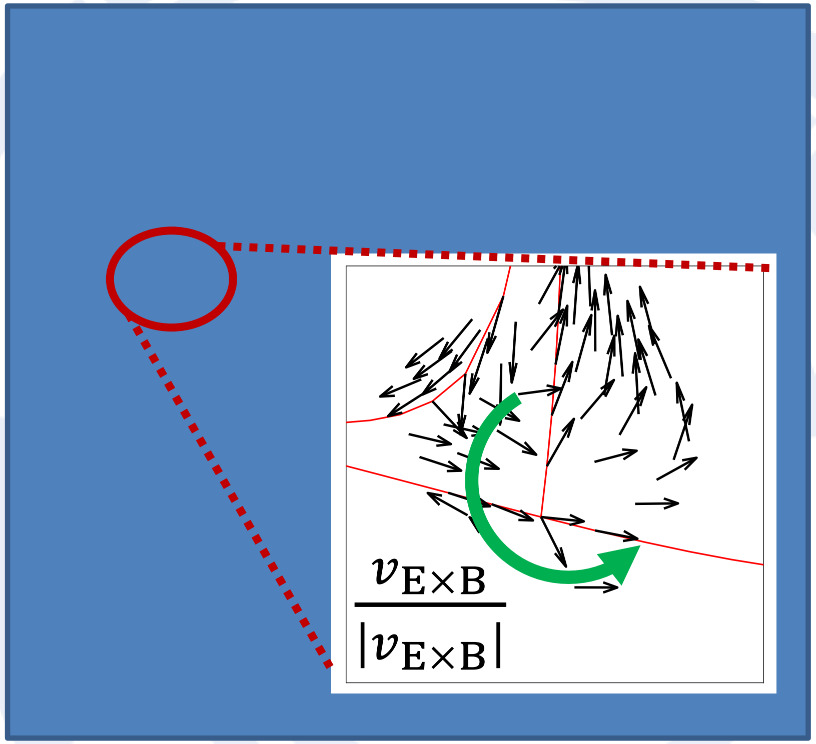
- **Scientific Objectives**

1. validate SOLPS-ITER simulations
2. identify the optimal XPT shape and its sensitivity to dru_XP2
3. highlight the different mechanisms driving the XPT performance

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

<u>**TCV**</u>
  - Ohmic L-mode, fix dru_XP2 and scan density (5)
  - High-power EC-heated L-mode, fix dru_XP2 and scan density (5)
  - Diagnostic repeats (5)

Backup: fix density, scan geometry
Diagnostic: standard TCV edge diagnostics



Proposed pulses

Device	# Pulses/Session	# Development
TCV	15	5

#168: Investigation of the impact of secondary X-point radial distance from the separatrix on the X-point target performance

- **Proponents and contact person:**

Massimo Carpita | massimo.carpita@epfl.ch

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  - XPT has been shown to greatly reduce target temperature and heat fluxes compared to LSN, in different plasma scenarios
  - Recent SOLPS-ITER modelling shows a large sensitivity of the results to the secondary X-point separation in radial space (dru_XP2, mapped upstream), due to ExB-driven redistribution of particles around the secondary X-point

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1. validate SOLPS-ITER simulations
2. identify the optimal XPT shape and its sensitivity to dru_XP2
3. highlight the different mechanisms driving the XPT performance

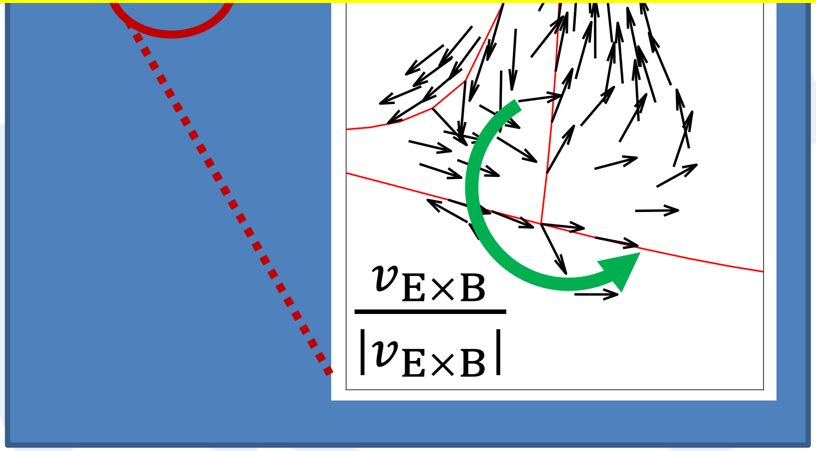
- **Experimental Strategy/Machine Constraints and essential diagnostic**

<u>**TCV**</u>

- Ohmic L-mode, fix dru_XP2 and scan density (5)
- High-power EC-heated L-mode, fix dru_XP2 and scan density (5)
- Diagnostic repeats (5)

Backup: fix density, scan geometry
Diagnostic: standard TCV edge diagnostics

P1-TCV-2027
Specific proposal for SOLPS-ITER modelling validation in the XPT configuration. High priority but at a later stage than other proposals.



Proposed pulses

Device	# Pulses/Session	# Development
TCV	15	5

MAST-U specific proposals

#159: High-power core-edge development for ADC exploration

- **Proponents and contact person:**

K. Verhaegh, J. Lovell, et al.

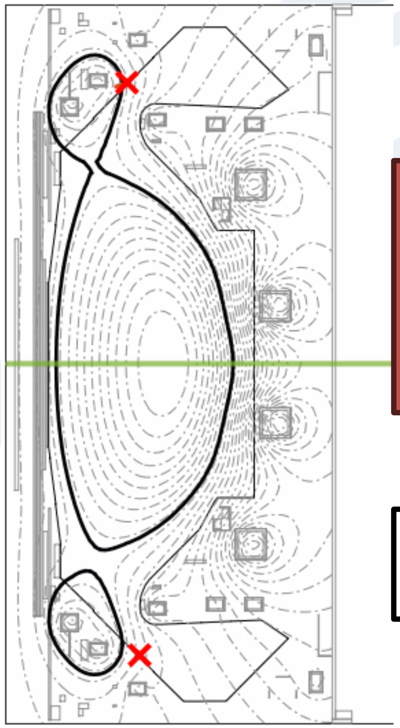
- **Scientific Background & Objectives**
  - High power and low density scenarios that optimize $P_{SOL}/(\lambda_q * n_e)$ required for testing divertor in low-powered devices (TCV, MAST-U)
  - TCV's 'undetachable scenario' optimizes this -> game changer in demonstrating ADC benefits
  - Significant MAST-U H-mode development required to for the Super-X, cost much of the RT07 allocation without dedicated proposal
  - ➢ Shows need for having a scenario development proposal in RT07
- **Experimental Strategy/Machine Constraints and essential diagnostic**

MAST-U:

- Develop improved H-mode scenario MAST-U for ADC studies
- Develop analogous 'undetachable' scenario for MAST-U LSN, optimizing $P_{SOL}/(\lambda_q * n_e)$
- Repeat baseline studies in improved scenarios

TCV: See high power TBLLD proposal H. Reimerdes

AUG: Further investigation needed to see if scenario development proposal is required.



MAST-U best SXD H-mode with full power in MU04

Remains deeply detached !

X = ionization front (~ 3 eV)

Proposed pulses

Device	# Pulses/Session	# Development
MAST-U	6	18

#159: High-power core-edge development for ADC exploration

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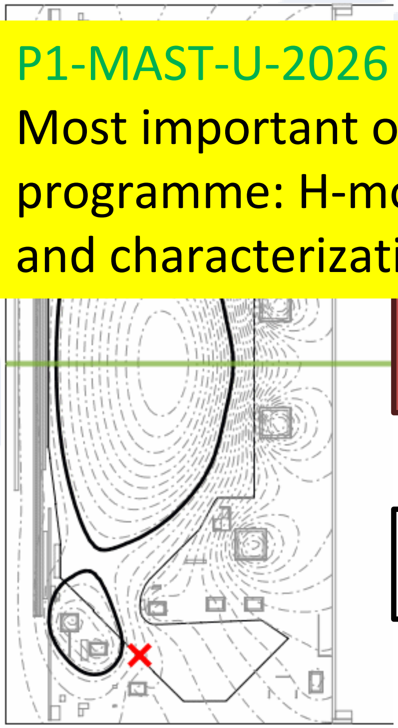
- Repeat baseline studies in improved scenarios

TCV: See high power TBLLD proposal H. Reimerdes

AUG: Further investigation needed to see if scenario development proposal is required.

P1-MAST-U-2026

Most important objective on the MAST-U programme: H-mode scenario development and characterization



Remains deeply detached !

X = ionization front (~ 3 eV)

Proposed pulses

Device	# Pulses/Session	# Development
MAST-U	6	18

#172: Impact of total flux expansion and divertor turbulence on PFR broadening

Proponents and contact person:
peter.ryan@ukaea.uk,..

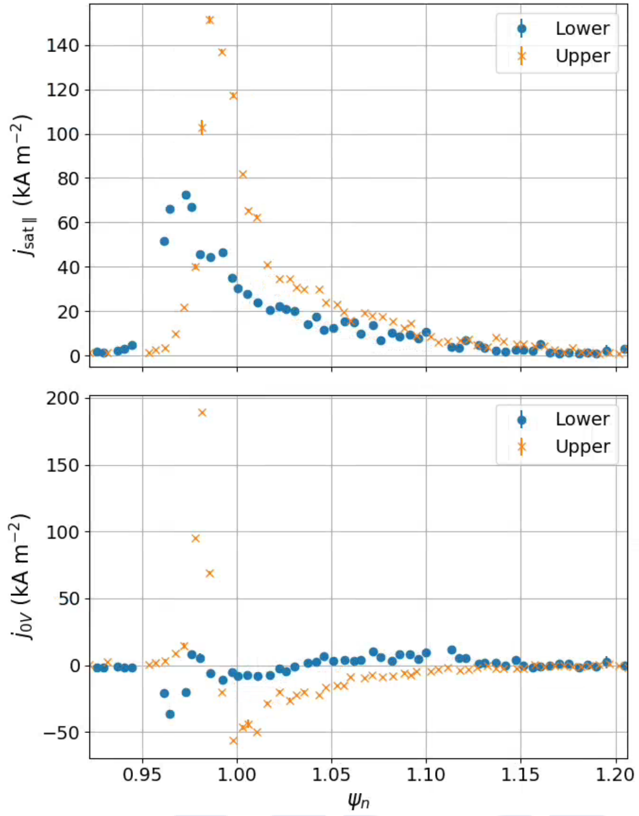
Scientific Background & Objectives

- Cross-field transport in the X-point/divertor region spreads heat and particle fluxes onto a larger wetted area, including into the private flux region (PFR).
- Several mechanisms have been proposed for driving particle and heat flux broadening in attached conditions: Pfirsch-Schluter currents in the PFR, E×B drifts, ionisation sources and turbulent transport.

➢ Assess the impact of outer strike point radius on PFR profile broadening (heat flux, j_{sat}, current to tiles).
➢ Compare PFR broadening in upper and lower divertors during double-null experiments.
➢ Assess the impact of turbulence in the divertor region (PFR and SOL) on profile broadening for different ADCs.

Experimental Strategy/Machine Constraints and essential diagnostics

- LP, IR, CIS, IDA on MAST-U for profiles. Fast cameras to assess turbulent transport in the divertor region.
- Outer R strike point scan in double-null.
- Assess PFR width in different ADCs.



Proposed pulses

Device	# Pulses	# Development
MAST-U	4	6

#172: Impact of total flux expansion and divertor turbulence on PFR broadening

Proponents and contact person:
peter.ryan@ukaea.uk,..

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➢ Compare PFR broadening in upper and lower divertors during double-null experiments.

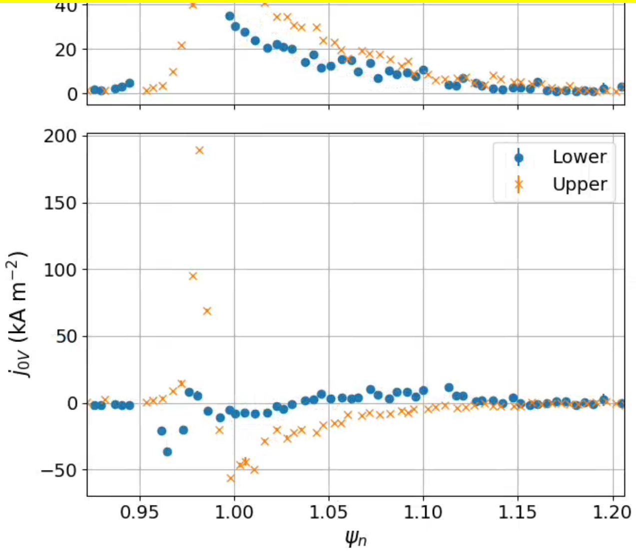
➢ Assess the impact of turbulence in the divertor region (PFR and SOL) on profile broadening for different ADCs.

Experimental Strategy/Machine Constraints and essential diagnostics

- LP, IR, CIS, IDA on MAST-U for profiles. Fast cameras to assess turbulent transport in the divertor region.
- Outer R strike point scan in double-null.
- Assess PFR width in different ADCs.

PB

The studies can be almost completely done PB – combine with #159 and other MAST-U proposals.



Proposed pulses

Device	# Pulses	# Development
MAST-U	4	6

Multimachine proposals

#158: Outer target optimisation through a continuum of total and poloidal flux expansion

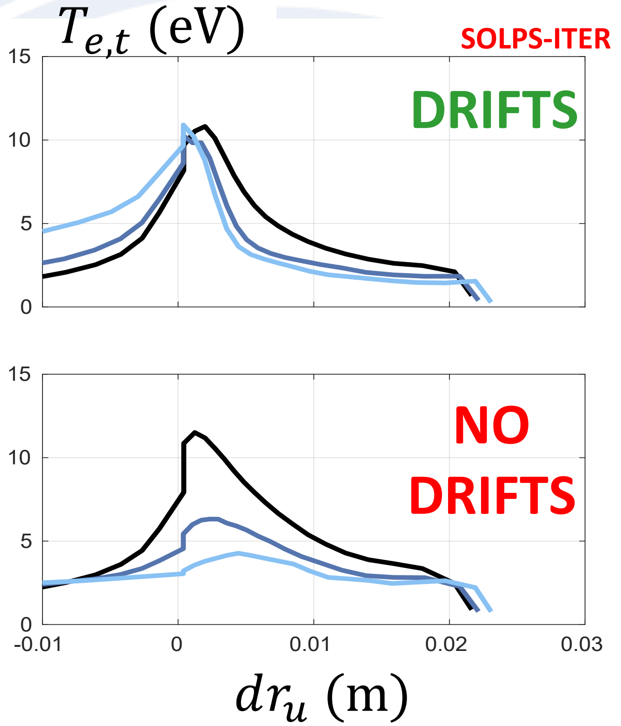
- **Proponents and contact person:**

K. Verhaegh, et al. k.h.a.Verhaegh@tue.nl

No T_t reduction with F_x in TCV in reversed field

Same in H-mode (forward field) ?

- **Scientific Background & Objectives**
  - Last year: 1) Power exhaust MAST-U **Super-X maintained** at more **moderate target radius**, can we trade-off total & poloidal flux expansion?
  - **Last year:** TCV showed limited benefits poloidal flux expansion, consistent with simulations (drifts). Does MAST-U see the same?



- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Investigate impact of poloidal flux expansion on detachment in MAST-U to see trade-off total & poloidal flux expansion
  - H-mode forward field F_x scans in TCV to see if the same reduced poloidal flux expansion is observed
  - Investigate benefit intermediate configurations with N_2 seeding

Proposed pulses

Device	# Pulses/Session	# Development
MAST-U	8	4
TCV	8	2

#158: Outer target optimisation through a continuum of total and poloidal flux expansion

- **Proponents and contact person:**

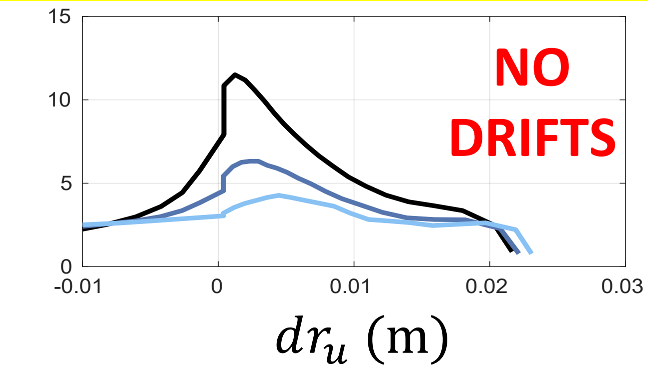
K. Verhaegh, et al. k.h.a.Verhaegh@tue.nl

No T_t reduct
F_x in TCV in rev

Same in H-mode (f

P1-TCV-2026
P1-MAST-U-2026
Straightforward continuation of last year's experiments, could be finished quickly but potentially with reduced shot numbers

- **Scientific Background & Objectives**
  - Last year: 1) Power exhaust MAST-U **Super-X maintained** at more **moderate target radius**, can we trade-off total & poloidal flux expansion?
  - **Last year:** TCV showed limited benefits poloidal flux expansion, consistent with simulations (drifts). Does MAST-U see the same?



- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Investigate impact of poloidal flux expansion on detachment in MAST-U to see trade-off total & poloidal flux expansion
  - H-mode forward field F_x scans in TCV to see if the same reduced poloidal flux expansion is observed
  - Investigate benefit intermediate configurations with N_2 seeding

Proposed pulses

Device	# Pulses/Session	# Development
MAST-U	8	4
TCV	8	2

#160: Multi-machine study of power exhaust in the X-point target configuration

Proponents and contact persons:

Kenneth Lee (kenneth.lee@epfl.ch)

Scientific Background

- X-point target (XPT) shows facilitated access to stable detachment front position, with the formation of X-point target radiator (XPTR)
- Significant type-I ELM buffering observed
- Improved operation in LSN-XPT and DN-XPT on both TCV and MAST-U

Objectives

- Comparative studies of XPT detachment in high power scenarios on TCV and MAST-U to expand machine parameter space
- Quantify power exhaust, detachment onset, front stability, (ELM transport)
- Focus on DN-XPT and H-mode
- Compare power exhaust performance and identify key physics drivers

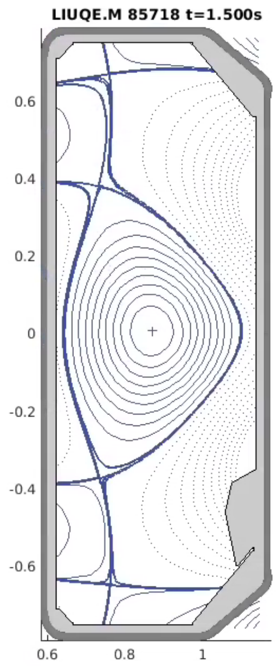
Experimental Strategy

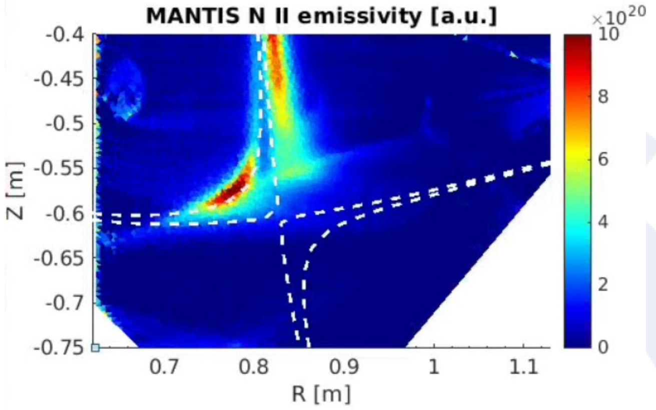
TCV

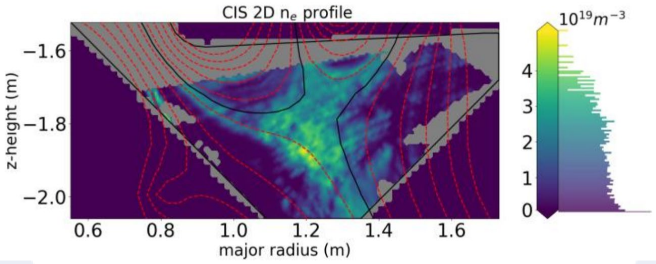
- Develop high power H-mode scenarios from NBI+X3 heated PEX, in DN-XPT, LSN-XPT
- Advanced shape control and iteration to optimize dRx2
- N_2 seeding / fuelling, different injection schemes
- Tightly-baffled XPT to disentangle neutral compression effects

MAST-U

- Use available H-mode scenario to develop DN-XPT and LSN-XPT at max. power + cryopumping
- Shape development effort likely required
- Divertor fuelling / PFR fuelling / impurity seeding







Proposed pulses

Device	# Pulses/Session	# Development
MAST-U	20	5
TCV	40	10

#160: Multi-machine study of power exhaust in the X-point target configuration

Proponents and contact persons:

Kenneth Lee (kenneth.lee@epfl.ch)

Scientific Background

- X-point target (XPT) shows facilitated access to stable detachment front position, with the formation of X-point target radiator (XPTR)
- Significant type-I ELM buffering observed
- Improved operation in LSN-XPT and DN-XPT on both TCV and MAST-U

Objectives

- Comparative studies of XPT detachment in high power scenarios on TCV and MAST-U to expand machine parameter space
- Quantify power exhaust, detachment onset, front stability, (ELM transport)
- Focus on DN-XPT and H-mode
- Compare power exhaust performance and identify key physics drivers

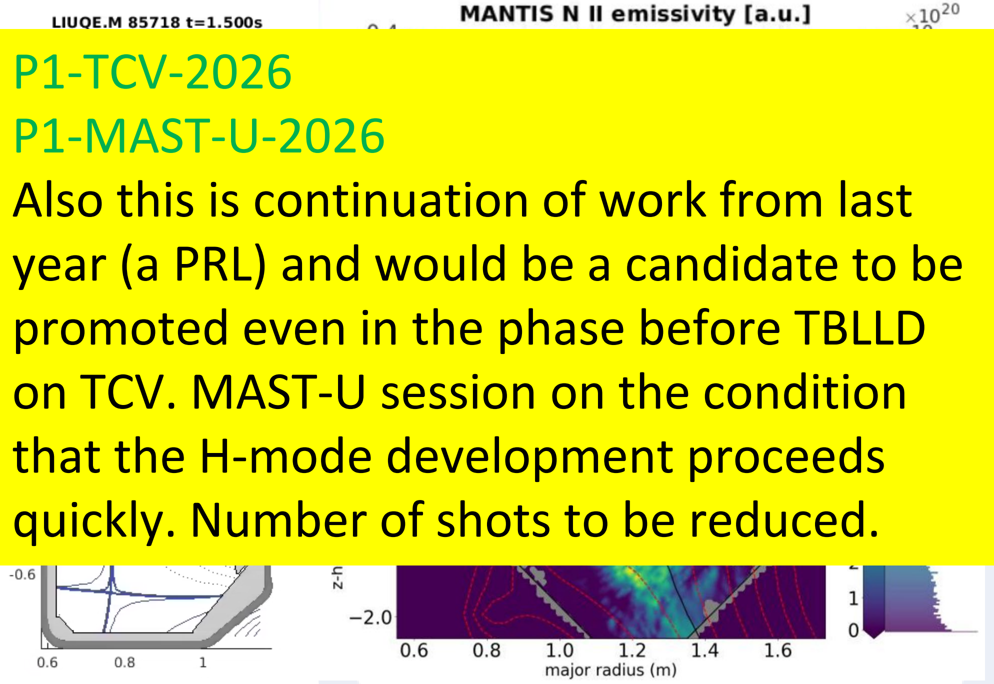
Experimental Strategy

TCV

- Develop high power H-mode scenarios from NBI+X3 heated PEX, in DN-XPT, LSN-XPT
- Advanced shape control and iteration to optimize dRx2
- N_2 seeding / fuelling, different injection schemes
- Tightly-baffled XPT to disentangle neutral compression effects

MAST-U

- Use available H-mode scenario to develop DN-XPT and LSN-XPT at max. power + cryopumping
- Shape development effort likely required
- Divertor fuelling / PFR fuelling / impurity seeding



P1-TCV-2026

P1-MAST-U-2026

Also this is continuation of work from last year (a PRL) and would be a candidate to be promoted even in the phase before TBLLD on TCV. MAST-U session on the condition that the H-mode development proceeds quickly. Number of shots to be reduced.

Proposed pulses

Device	# Pulses/Session	# Development
MAST-U	20	5
TCV	40	10

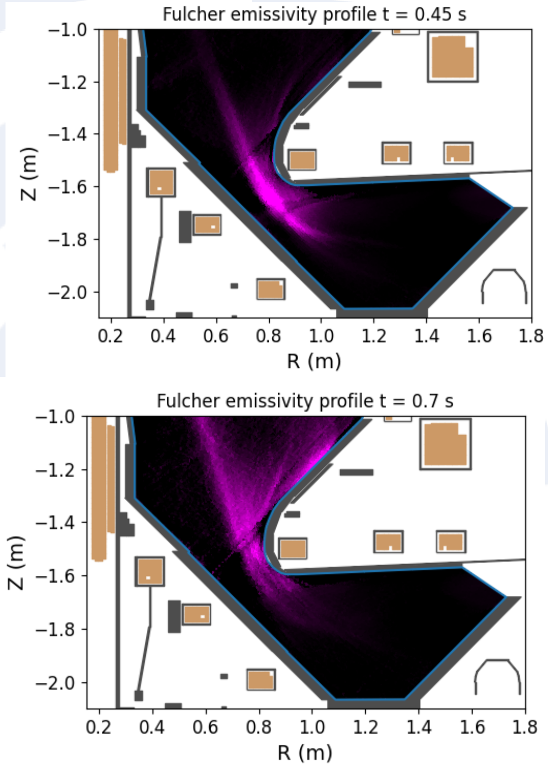
#165: Impurity transport in strongly baffled ADCs

- **Proponents and contact person:**
  - MAST-U Team: N. Lonigro (nicola.lonigro@ukaea.uk), C. Beckley, N. Bundschuh, S. Menmuir, D. Moulton, R. Osawa, K. Verhaegh, L. Xiang, S. Kobussen
  - TCV Team: R.Morgan(riccardo.morgan@epfl.ch), M. Cornelissen, R. Ducker, D. Mykytchuk, A. Perek, B. Brown, O. Février, H. Reimerdes, C. Theiler

- **Scientific Background & Objectives**
  - Transport of impurities from the divertor to the main chamber and core will influence the integrated core-edge scenario.
  - **Strong baffling can improve neutral retention** in the divertor region, even in detached conditions. Increased leakage of D neutrals to main chamber observed when the ionization front exist the divertor throat in MAST-U. **Explore how this behavior extends to impurities** and ADCs.
  - Quantify improvements in impurity transport from the divertor to the main chamber in strongly baffled ADCs as a function of magnetic geometry, impurity species, ionization front position, and in the presence of ELMs (D1). Create dataset for validation high-fidelity simulations of impurity transport (D4).

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Use fueling steps to change ionization front position and for each step perform small (ideally non-perturbative) puffs of impurities in the divertor. Use difference in main chamber spectroscopy and CXRS impurity line signals to quantify leakage.
  - Type I ELMs can strongly affect compression but are not reactor relevant → Focus on L-mode discharges for cleaner diagnostic data and modelling comparisons. Then compare to H-mode discharges to quantity the effect of ELMs on impurity compression.

Increased leakage as ionization region exits baffle. What about impurities?



Proposed pulses

Device	# Pulses/Session	# Development
MAST-U	29	3
TCV	25	3

#165: Impurity transport in strongly baffled ADCs

- **Proponents and contact person:**
  - MAST-U Team: N. Lonigro (nicola.lonigro@ukaea.uk), C. Beckley, N. Bundschuh, S. Menmuir, D. Moulton, R. Osawa, K. Verhaegh, L. Xiang, S. Kobussen
  - TCV Team: R.Morgan(riccardo.morgan@epfl.ch), M. Cornelissen, R. Ducker, D. Mykytchuk, A. Perek, B. Brown, O. Février, H. Reimerdes, C. Theiler

- **Scientific Background & Objectives**
  - Transport of impurities from the divertor to the main chamber and core will influence the integrated core-edge scenario.
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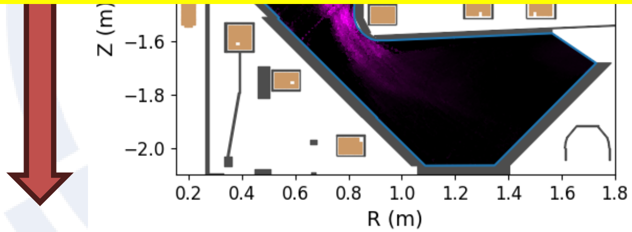
- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Use fueling steps to change ionization front position and for each step perform small (ideally non-perturbative) puffs of impurities in the divertor. Use difference in main chamber spectroscopy and CXRS impurity line signals to quantify leakage.
  - Type I ELMs can strongly affect compression but are not reactor relevant → Focus on L-mode discharges for cleaner diagnostic data and modelling comparisons. Then compare to H-mode discharges to quantity the effect of ELMs on impurity compression.

P1-TCV-2027
P1-MAST-U-2026
The outcomes of the proposal will be essential in benchmarking modelling results. On TCV, however, to be scheduled at a later stage and concentrate first on MAST-U – subject to scenario development being successful.

about impurities ?



Proposed pulses

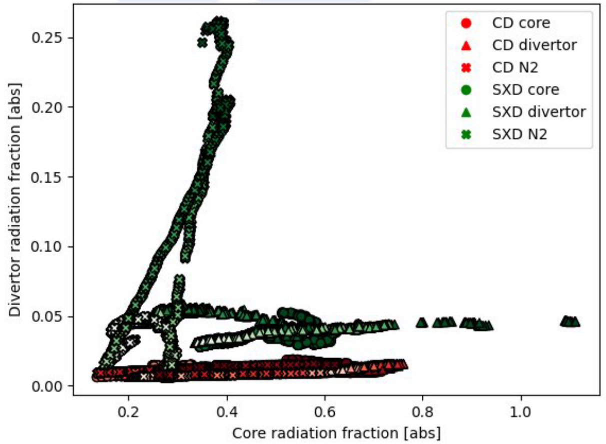
Device	# Pulses/Session	# Development
MAST-U	29	3
TCV	25	3

#174: Core-divertor integrated power exhaust study with impurity seeding

- **Proponents and contact person:**

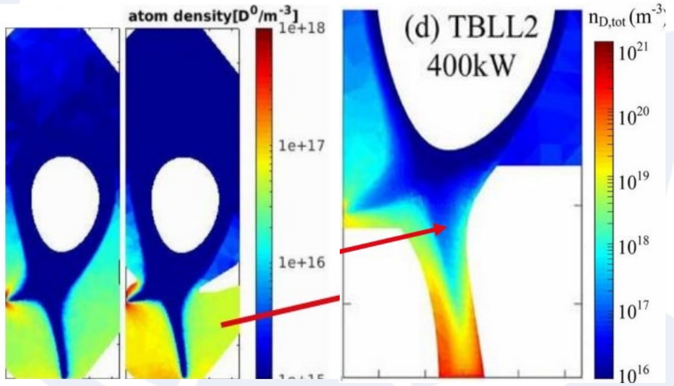
Lingyan Xiang(lingyan.Xiang@ukaea.uk), Riccardo Ian Morgan(riccardo.morgan@epfl.ch)

- **Scientific Background & Objectives**
  - Background –
  - MAST-U MU03/04 experiments showed that in ADCs the divertor decouples more from the core. Now we want to
  - Assess level of cross-talk between divertors (does seeding in the upper divertor influence the lower divertor?)
  - What is the radiation pattern in a Double-Null ? Can double-XPR exist, and, if so, under what conditions ?
  - How does different seeded impruties impact the radiation pattern and core contamination?
  - Objectives –
    1. Investigate core-divertor decoupling regarding impurity screening from the core with different seeding locations in the divertor at different divertor conditions and with different impurities (N_2, Ar. Low to very high seeding rates to match the seeding scenarios on reactors).
    2. Continue the study and gather stronger evidence for the different impacts of impurity seeding in various divertor geometries, regarding (a) radiation distribution, (b) divertor pressure, (c) power decay length, (d) parallel temperature gradient, (e) the detachment front sensitivity, (f) the impurity compression and (g) core contamination.



MAST-U SXD has much higher divertor radiation than CD

TCV TBLLD achieves higher neutral pressure in the divertor



- **Experimental Strategy/Machine Constraints**
  - **TCV :**

    Experiments to assess the required N_2 seeding for achieving detachment at different levels of P_{sol}, with the TBLLD configuration.
  - **MAST-U:**
    1. Experiments to test how deep the detachment can get by impurity seeding alone. Ramp impurity seeding at different rates at core density of 1.0-2.0 in CD and SXD. Do this in DN/LSN-Hmode with 2 beams. Impurity species include N_2 and Ar.
    2. Experiments to complete the database (matrix of (a) core fuelling & divertor fuelling & seeding, (b) in L-mode & H-mode, (c) in DN & LSN, (d) with & without cryopump). The missing experiments are: Lmode-DN-cryoon-seeding-CD/SXD, Lmode-LSN-cryoon-seeding-CD/SXD, Hmode-DN-cryoon-seeding-SXD, Hmode-DN-cryoon-divertorfuelling-CD/SXD, Hmode-DN-cryoon-seeding-CD/SXD, Hmode-LSN-cryoon-divertorfuelling-CD/SXD, Hmode-LSN-cryoon-seeding-CD/SXD.

Device	# Pulses/Session	# Development
MAST-U	14	0
TCV	13	0

#174: Core-divertor integrated power exhaust study with impurity seeding

- **Proponents and contact person:**
Lingyan Xiang(lingyan.Xiang@ukaea.uk), Riccardo Ian Morgan(riccardo.morgan@epfl.ch)
- **Scientific Background & Objectives**
  - Background –
  - MAST-U MU03/04 experiments showed that in ADCs the divertor decouples more from the core. No want to
  - Assess level of cross-talk between divertors (does seeding in the upper divertor influence the lower
  - What is the radiation pattern in a Double-Null ? Can double-XPR exist, and, if so, under what conditi
  - How does different seeded impruties impact the radiation pattern and core contamination?
  - Objectives –
    1. Investigate core-divertor decoupling regarding impurity screening from the core with different locations in the divertor at different divertor conditions and with different impurities (N_2, Ar. L high seeding rates to match the seeding scenarios on reactors).
    2. Continue the study and gather stronger evidence for the different impacts of impurity seeding in various divertor geometries, regarding (a) radiation distribution, (b) divertor pressure, (c) power decay length, (d) parallel temperature gradient, (e) the detachment front sensitivity, (f) the impurity compression and (g) core contamination.
- **Experimental Strategy/Machine Constraints**
  - **TCV :**
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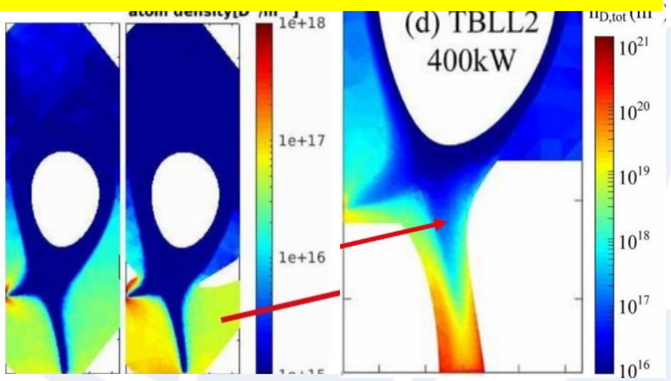
    1. Experiments to test how deep the detachment can get by impurity seeding alone. Ramp impurity seeding at different rates at core density of 1.0-2.0 in CD and SXD. Do this in DN/LSN-Hmode with 2 beams. Impurity species include N_2 and Ar.
    2. Experiments to complete the database (matrix of (a) core fuelling & divertor fuelling & seeding, (b) in L-mode & H-mode, (c) in DN & LSN, (d) with & without cryopump). The missing experiments are: Lmode-DN-cryoon-seeding-CD/SXD, Lmode-LSN-cryoon-seeding-CD/SXD, Hmode-DN-cryoon-seeding-SXD, Hmode-DN-cryoon-divertorfuelling-CD/SXD, Hmode-DN-cryoon-seeding-CD/SXD, Hmode-LSN-cryoon-divertorfuelling-CD/SXD, Hmode-LSN-cryoon-seeding-CD/SXD.

P1-TCV-2026
P2-MAST-U
The TCV part would benefit TBLLD investigations in the presence of impurities. The MAST-U part could be considered once the more straightforward investigations under #165 are completed.

achieves higher neutral pressure in the divertor



Device	# Pulses/Session	# Development
MAST-U	14	0
TCV	13	0

#163: Effect of magnetic balance, divertor geometry, and fuelling/seeding location on radiation in DN plasmas.

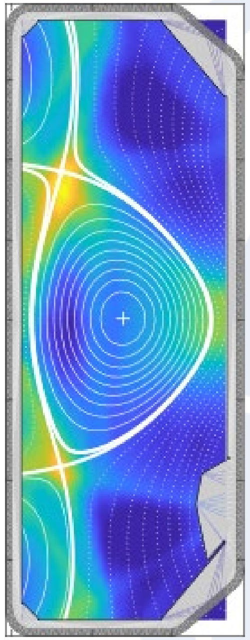
- **Proponents and contact person:**

Nicola Lonigro (nicola.lonigro@ukaea.uk), J. Lovell, Olivier Février, David Moiraf, Kevin Verhaegh, Lingyan Xiang, Nicolas Fedorczak, Nicolas Rivals, Christian Theiler, Michal Czarski, Radhika Mishra

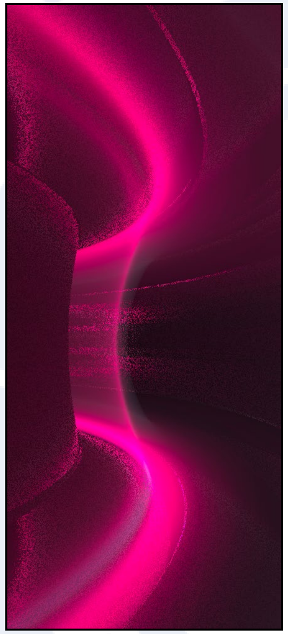
Scientific Background & Objectives

- Investigate the role of the seeding/fuelling location as well as magnetic balance (dRsep) and magnetic geometry (conventional vs ADCs) on DN divertors power balance and detachment access.
- Assess level of cross-talk between divertors (does seeding in the upper divertor influence the lower divertor? Does it depend on detachment state?)
- Can the location of the XPR on WEST be controlled by varying the magnetic geometry, as previously done on TCV?

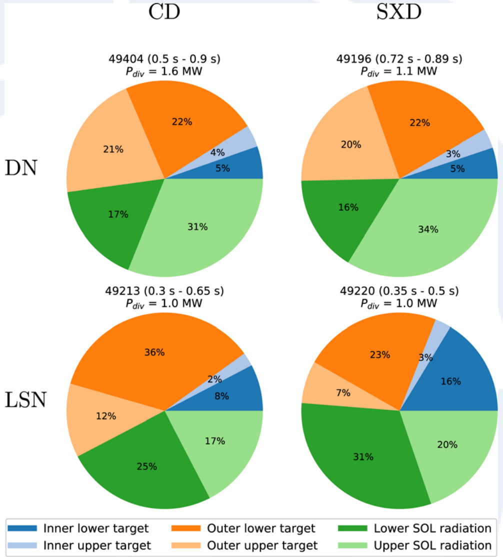
TCV: radiation at lower&upper xpts



Double radiation front in WEST from SOLEDGE3X simulation



Power sharing on MAST-U in SN and DN with conventional and Super-X divertor



- **Experimental Strategy/Machine Constraints**

TCV : Ohmic L-Mode and NBH-heated H-Mode on TCV in DN

Shots should fill possible gaps identified in the RT07-2024/2025, TCV internal dataset

WEST :

Compare N_2-seeding-driven onset of XPR(s) in SN and DN. Is the core dilution lower in DN?
Investigate location of XPR when varying dRsep, drift direction, and seeding location.
Extend study to H-mode, if available.

MAST-U:

- L-mode DN density ramp for detailed 2D validation of drifts effect in SOLPS simulations.
- High-resolution H-mode dRsep scan in conventional and Super-X divertor. Check ADC effect on power balance.
- Asymmetric H-mode N_2 seeding ramps in the two divertor chambers to study cross-talk.

Proposed pulses

Device	# Pulses/Session	# Development
MAST-U	33	3
TCV	10	0
WEST	32	0

#163: Effect of magnetic balance, divertor geometry, and fuelling/seeding location on radiation in DN plasmas.

- **Proponents and contact person:**

Nicola Lonigro (nicola.lonigro@ukaea.uk), J. Lovell, Olivier Février, David Moiraf, Kevin Verhaegh, Lingyan Xiang, Nicolas Fedorczak, Nicolas Rivals, Christian Theiler, Michal Czarski, Radhika Mishra

Scientific Background & Objectives

- Investigate the role of the seeding/fuelling location as well as magnetic balance (dRsep) and magnetic geometry (conventional vs ADCs) on DN divertors power balance and detachment access.
- Assess level of cross-talk between divertors (does seeding in the upper divertor influence the lower divertor? Does it depend on detachment state?)
- Can the location of the XPR on WEST be controlled by varying the magnetic geometry, as previously done on TCV?

- **Experimental Strategy/Machine Constraints**

TCV : Ohmic L-Mode and NBH-heated H-Mode on TCV in DN

Shots should fill possible gaps identified in the RT07-2024/2025, TCV internal dataset

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Compare N_2-seeding-driven onset of XPR(s) in SN and DN. Is the core dilution lower in DN?
Investigate location of XPR when varying dRsep, drift direction, and seeding location.
Extend study to H-mode, if available.

MAST-U:

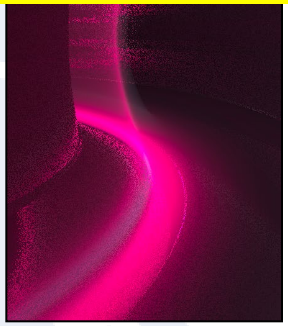
- L-mode DN density ramp for detailed 2D validation of drifts effect in SOLPS simulations.
- High-resolution H-mode dRsep scan in conventional and Super-X divertor. Check ADC effect on power balance.
- Asymmetric H-mode N_2 seeding ramps in the two divertor chambers to study cross-talk.

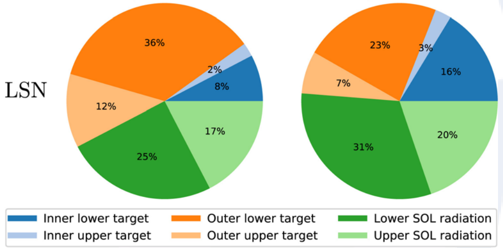
TCV ... low...

Double radiation front

Power sharing on MAST-U in SN

P2-TCV
P2-MAST-U
P1-WEST-2026
Main machine in 2026 will be WEST, work on other devices should be based on data mining under WPTE.





Proposed pulses

Device	# Pulses/Session	# Development
MAST-U	33	3
TCV	10	0
WEST	32	0

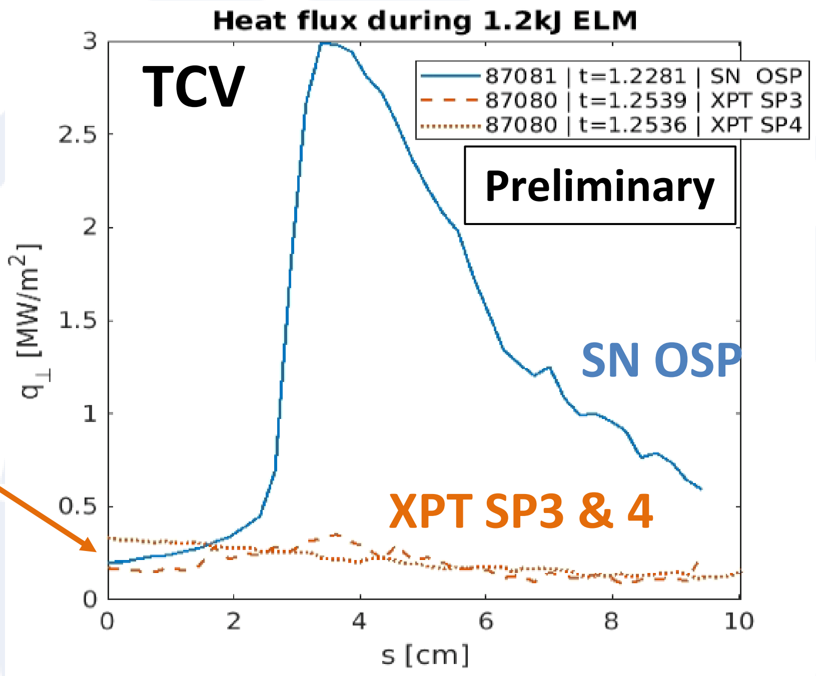
#148: ELM and transient buffering in ADCs of AUG, MAST-U and TCV

Proponents and contact persons:

AUG: Felix Albrecht (felix.albrecht@ipp.mpg.de), D. Brida, H. Lindl, A. Mancini, M. Herschel, T. Lunt, B. Sieglin, O. Pan, M. Faitsch, M. Komm. MAST-U: Jack Flanagan (jack.flanagan@ukaea.uk), R. Scannell, K. Verhaegh, P. Figueiredo, S. Reddy, D. Moulton, S. Kobussen. TCV: Martim Zurita (martim.zurita@epfl.ch), H. Reimerdes, K. Lee, C. Theiler, O. Février, M. Carpita, Y. Wang.

Scientific Background

1. Up to 60% ELM buffering in AUG with single-null (SN) [M. Komm, NF (2023)]
2. ELM buffering in MAST-U w/ Super-X [J. Flanagan, NF (2025)]
3. Strong ELM buffering in TCV with the x-point target (XPT) [M. Zurita, APS (2025)]



Objectives

Directly linked to RT07 D3: ELM heat load mitigation in ADC

Objectives at AUG

1. Observe and quantify the buffering of ELMs in the upper divertor
2. Assess the influence of fuelling and seeding, in terms of neutral pressure
3. Compare performance between USN, XD and SF-, and the impact of dr_{x2}

Objectives at MAST-U

1. Measure the transient buffering benefits of the baffled Super-X vs Conventional divertor
2. Assess maximum ELM energy that the Super-X can buffer with seeding
3. Study the physics of detached buffering mechanisms with novel spectroscopic techniques
4. Validate buffering modelling in RemKiT1D and SOLPS, and reduced models for control

Objectives at TCV

1. Understand the mechanisms behind the XPT ELM buffering (XD vs SXD vs XPT, dr_{x2})
2. Assess maximum ELM energy that the XPT can buffer (and add seeding if needed)
3. Compare ELM buffering in XPT and snowflake divertors
4. Compare seeded buffering in SN and XPT

Experimental Strategy/Machine Constraints and essential diagnostic

- Compare type-I ELM buffering fraction in SN and ADCs
- **Diagnostics.** AUG: IR, LPs, Gas Puff Imaging, Div. Spectroscopy. MAST-U: Fast IR, Fast MWI, ultrafast divertor spectroscopy. TCV: IR, FastCam
- **Heating.** ECRH, NBI
- **Seeding.** AUG: N_2, Ar. MAST-U: unseeded, N_2. TCV: unseeded, N_2, Ne, Ar

Proposed pulses

Device	# Pulses/Session	# Development
AUG	10	2
MAST-U	12	4
TCV	17	18

#148: ELM and transient buffering in ADCs of AUG, MAST-U and TCV

Proponents and contact persons:

AUG: Felix Albrecht (felix.albrecht@ipp.mpg.de), D. Brida, H. Lindl, A. Mancini, M. Herschel, Lunt, B. Sieglin, O. Pan, M. Faitsch, M. Komm. MAST-U: Jack Flanagan (jack.flanagan@ukaea. R. Scannell, K. Verhaegh, P. Figueiredo, S. Reddy, D. Moulton, S. Kobussen. TCV: Martim Zuri (martim.zurita@epfl.ch), H. Reimerdes, K. Lee, C. Theiler, O. Février, M. Carpita, Y. Wang.

Scientific Background

1. Up to 60% ELM buffering in AUG with single-null (SN) [M. Komm, NF (2023)]
2. ELM buffering in MAST-U w/ Super-X [J. Flanagan, NF (2025)]
3. Strong ELM buffering in TCV with the x-point target (XPT) [M. Zurita, APS (2025)]

Heat flux during 1.2kJ ELM

P1-AUG-2027

P1-TCV-2027

P2-MAST-U

Very important topic on all the devices (objective D3) but due to other priorities should be executed after TBLLD (TCV) and fundamental scenario development (AUG). On MAST-U subject to success in scenario development.

s [cm]

Objectives

Directly linked to RT07 D3: ELM heat load mitigation in ADC

Objectives at AUG

1. Observe and quantify the buffering of ELMs in the upper divertor
2. Assess the influence of fuelling and seeding, in terms of neutral pressure
3. Compare performance between USN, XD and SF-, and the impact of dr_{x2}

Objectives at MAST-U

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1. Understand the mechanisms behind the XPT ELM buffering (XD vs SXD vs XPT, dr_{x2})
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3. Compare ELM buffering in XPT and snowflake divertors
4. Compare seeded buffering in SN and XPT

Experimental Strategy/Machine Constraints and essential diagnostic

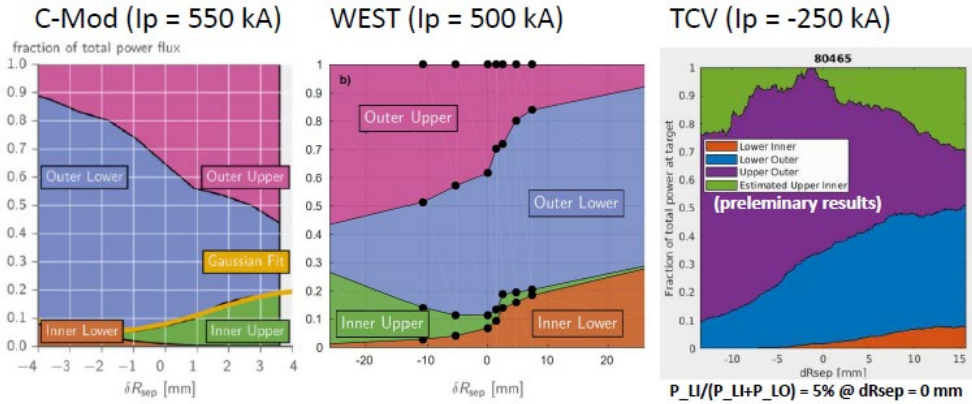
- Compare type-I ELM buffering fraction in SN and ADCs
- **Diagnostics.** AUG: IR, LPs, Gas Puff Imaging, Div. Spectroscopy. MAST-U: Fast IR, Fast MWI, ultrafast divertor spectroscopy. TCV: IR, FastCam
- **Heating.** ECRH, NBI
- **Seeding.** AUG: N_2, Ar. MAST-U: unseeded, N_2. TCV: unseeded, N_2, Ne, Ar

Proposed pulses

Device	# Pulses/Session	# Development
AUG	10	2
MAST-U	12	4
TCV	17	18

#175: Assess the risk of re-attachment during the lost of DN magnetic balance in various ADCs for future reactors

- **Proponents and contact person:**
  Lingyan Xiang(lingyan.Xiang@ukaea.uk)
- **Scientific Background & Objectives**
  – Objectives:
    - Assess whether and at what dRsep values the inner and/or outer target re-attaches as the magnetic configuration departs from balanced DN at the highest P_{SEP}/R values of each tokamak.
    - Investigate whether ADCs provide buffer against or render more acute the re-attachment of the inner and outer target during the transition. Find out what ADC provides buffer against reattachment both for the outer and the inner target.
    - Explore how baffling or the lack of it impacts the divertor re-attachment during DN=>SN transition by comparing the performance across the different machines with different divertor baffling
    - Study if certain drift direction offer more buffering against risk of re-attachment by doing DN=>LSN vs DN=>USN transitions on the machines where possible



Device	# Pulses/Session	# Development
AUG	4	0
MAST-U	8	0
TCV	10	0
WEST	4	0

- **Experimental Strategy/Machine Constraints**

On MAST-U:

1. 2 reference shots in CD. #1: develop DN-2B plasma in H-mode with high ELM frequency (grassy ELM) to keep the density stable if possible. Slowly increasing dRsep, moving the magnetic configuration away from balanced DN and finishing in LSN. #2: in the same 2 beam heated grassy ELMy H-mode, do the CDN=>DDN=>USN transition instead to see the impact of drift direction in re-attachment. In both reference shots, apply impurity seeding at fixed rate 60 ms (the time from valve opening to plasma) prior to the formation of the desired divertor shape.
2. Then repeat the two reference plasmas for different ADCs including (1) closed CD with SP at 1.0 m, (2) SXD, (3) XPT.

On TCV:

1. First run a reference shot with the lower X-point being between the baffles and the outer divertor leg being vertically down. Change the magnetic equilibrium from CDN to DDN then to LSN. Apply constant impurity seeding to the pulse.
2. The repeat the experiment for ADCs, which include (1) long-legged vertical outer leg, (2) XD with vertical leg and large poloidal flux expansion, (3) SXD with SP at largest R_t, (4) XPT.

On AUG: 4 shot: Use highest heating power available to have more reactor relevant P_{sep}/R. Once DN configuration is developed, use N_2/Ar seeding to drive all targets into detachment. Slowly transition from CDN to DDN then to LSN/USN, keeping the seeding rate constant.

On WEST: same experiment strategy as on AUG.

#175: Assess the risk of re-attachment during the lost of DN magnetic balance in various ADCs for future reactors

C-Mod (Ip = 550 kA) WEST (Ip = 500 kA) TCV (Ip = -250 kA)

- **Proponents and contact person:**
  Lingyan Xiang(lingyan.Xiang@ukaea.uk)
- **Scientific Background & Objectives**
  - Objectives:
    - Assess whether and at what dRsep values the inner and/or outer target re-attaches as the magnetic configuration departs from balanced DN at the highest P_{SEP}/R values of each tokamak
    - Investigate whether ADCs provide buffer against or render more acute the re-attachment of the inner and outer target during the transition. Find out what ADC provides buffer against reattachment both for the outer and the inner target.
    - Explore how baffling or the lack of it impacts the divertor re-attachment during DN=>SN transition by comparing the performance across the different machines with different divertor baffling
    - Study if certain drift direction offer more buffering against risk of re-attachment by doing DN=>LSN vs DN=>USN transitions on the machines where possible

P2-AUG
P2-TCV
P2-MAST-U
P2-WEST

Interesting proposal but feasibility questionable on several of the contributing devices and much work done already done under internal campaigns (e.g., MAST-U)

MAST-U	8	0
TCV	10	0
WEST	4	0

- **Experimental Strategy/Machine Constraints**

On MAST-U:

1. 2 reference shots in CD. #1: develop DN-2B plasma in H-mode with high ELM frequency (grassy ELM) to keep the density stable if possible. Slowly increasing dRsep, moving the magnetic configuration away from balanced DN and finishing in LSN. #2: in the same 2 beam heated grassy ELMy H-mode, do the CDN=>DDN=>USN transition instead to see the impact of drift direction in re-attachment. In both reference shots, apply impurity seeding at fixed rate 60 ms (the time from valve opening to plasma) prior to the formation of the desired divertor shape.
2. Then repeat the two reference plasmas for different ADCs including (1) closed CD with SP at 1.0 m, (2) SXD, (3) XPT.

On TCV:

1. First run a reference shot with the lower X-point being between the baffles and the outer divertor leg being vertically down. Change the magnetic equilibrium from CDN to DDN then to LSN. Apply constant impurity seeding to the pulse.
2. The repeat the experiment for ADCs, which include (1) long-legged vertical outer leg, (2) XD with vertical leg and large poloidal flux expansion, (3) SXD with SP at largest R_t, (4) XPT.

On AUG: 4 shot: Use highest heating power available to have more reactor relevant P_{sep}/R. Once DN configuration is developed, use N_2/Ar seeding to drive all targets into detachment. Slowly transition from CDN to DDN then to LSN/USN, keeping the seeding rate constant.

On WEST: same experiment strategy as on AUG.

#169: Dynamic response of ADCs to demonstrate reactor control & scenario integration benefits

- **Proponents and contact person:**

Paulo Figueiredo (p.a.marinhofigueiredo@differ.nl), Jorn Veenendaal, Max Winkel, Gijs Derks, Stijn Kobussen, Nicola Lonigro, Kevin Verhaegh, Matthijs Van Berkel

- **Scientific Background & Objectives**

Alternative divertor configurations (ADCs) have demonstrated reduced sensitivity of the detachment front to transients, both in quasi-steady-state and dynamic experiments. This provides us with a larger operational range and increased tolerance for transients. Characterizing these dynamics across configurations and operating points is essential to assess their impact on integrated control and to provide critical benchmarks for time-dependent models supporting reactor-scale exhaust design.

In this proposal, we aim to:
  - Expand the characterization of plasma dynamics in ADCs for different tokamaks and scenarios
  - Analyze the effect of impurities and valve location on detachment dynamics
  - Explore the interaction between inner and outer divertors detachment state

- **Experimental strategy and essential diagnostics**
- MAST-U:
  - System-identification with mixed N_2 and D_2 perturbations.
  - System-identification in H-mode to explore the possibility of ELM-buffering (requires UFDS)
  - System-identification for close to attached high elongation SN scenario in ADCs.
  - System-identification with PFR valve vs LFSD valve to probe interaction between inner and outer leg.
- AUG
  - Measure plasma dynamics for upper divertor snowflake configuration.
- TCV
  - Continue to measure plasma dynamics for LLD (long legged divertor) combined with SN and XPT configurations.

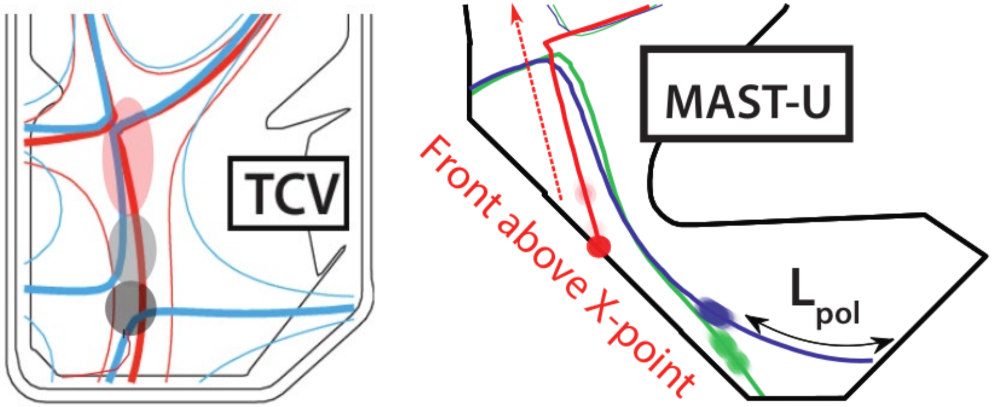


Fig: Illustration of varying sensitivities across ADCs in MAST-U and TCV

Proposed pulses

Device	# Pulses/Session	# Development
AUG	8	-
MAST-U	16	-
TCV	8	-

#169: Dynamic response of ADCs to demonstrate reactor control & scenario integration benefits

- **Proponents and contact person:**

Paulo Figueiredo (p.a.marinhofigueiredo@differ.nl), Jorn Veenendaal, Max Winkel, Gijs Derks, Stijn Kobussen, Nicola Lonigro, Kevin Verhaegh, Matthijs Van Berkel

- **Scientific Background & Objectives**

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- AUG
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- TCV
  – Continue to measure plasma dynamics for LLD (long legged divertor) combined with SN and XPT configurations.

P1-AUG-2027
P1-TCV-2027
P1-MAST-U-2026
System identification work should be pursued on varying ADC configurations but only at a later stage on AUG and TCV: try to include some discharges into the MAST-U programme in 2026.

Fig: Illustration of varying sensitivities across ADCs in MAST-U and TCV

Proposed pulses

Device	# Pulses/Session	# Development
AUG	8	-
MAST-U	16	-
TCV	8	-

Summary of the proposals and their priorities

#	Title	Proponents	Priority
144	Impact of flux expansion on X-point radiator access and associated transport in ADCs in AUG	Ou Pan	P1-AUG-2026
161	Power sharing and transport in SF- configuration	Dominik Brida	P1-AUG-2026
162	AUG SF- configuration comparison between AUG and TCV	Dominik Brida	P1-AUG-2026, P1-TCV-2026
176	Super Compact Radiative Divertor at 1MA	Tilmann Lunt	P1-AUG-2026
177	Stability of the LFS SF- configuration during type-I ELMs	Tilmann Lunt	P1-AUG-2026/PB
150	Nitrogen seeding scan for far SOL detachment in SF- at AUG	Alessandro Mancini	P1-AUG-2026
151	Nitrogen seeding scan for XD power exhaust investigation at AUG	Alessandro Mancini	P1-AUG-2026
152	Detachment study with positive and negative Bt at AUG	Alessandro Mancini	P2-AUG
166	Study of detachment in L-Mode during systematic parameter sweep in ADCs	Felix Albrecht	P2-AUG
149	Slow ADC configuration scan at AUG	Alessandro Mancini	P2-AUG/PB
142	I-mode access in alternative divertor configurations in ASDEX Upgrade	Davide Silvagni	P2-AUG
143	High-radiative and detached I-mode in alternative divertor configuration in ASDEX Upgrade	Davide Silvagni	P1-AUG-2027
171	RMP effects on the access of detachment in super-x divertor and X-divertor configurations	Yunfeng Liang	P2-AUG, P2-MAST-U
145	Impact of the secondary X-point on the radial electric field in near SOL in SF- and super-CRD config.	Ou Pan	P2-AUG
147	Interplay between X-point separation and power fall-off length in ASDEX Upgrade	Michael Faitsch	P1-AUG-2026
146	Far SOL transport and its interaction with W wall in ADCs in AUG	Ou Pan	P1-AUG-2026
141	Burn throughs in ADC in Hydrogen in AUG	Matthias Willensdorfer	P2-AUG
167	ELM-resolved upper divertor profiles from spectroscopic measurements in ADCs at AUG	Hannah Lindt	P1-AUG-2027
170	Scrape-off layer fluctuation measurements in ADCs at AUG	William Fuller	P1-AUG-2026

Summary of the proposals and their priorities

#	Title	Proponents	Priority
154	Optimization and Characterization of Power Exhaust at High Neutral Pressure in TCV’s TBLLD	Benjamin Brown	P1-TCV-2026
155	Detachment Front Evolution in a Chimney-like Configuration	Benjamin Brown	P2-TCV
156	High power dissipation in TCV's Tightly-Baffled, Long-Legged Divertor (TBLLD)	Holger Reimerdes	P1-TCV-2026
164	Power and Fuelling transients in the TBLLD	Olivier Février	P1-TCV-2026
173	Characterisation of turbulence and transport in the TBLLD	Christian Theiler	P1-TCV-2026/PB
153	Characterization of turbulence in X-point radiator H-mode scenarios on TCV	Yinghan Wang	P1-TCV-2027/PB
157	Detachment in high-power NT scenarios leveraging ADCs on TCV	Garance Durr-Legoupil-Nicaud	P1-TCV-2027
168	Impact of secondary X-point radial distance from the separatrix on the X-point target performance	Massimo Carpita	P1-TCV-2027
159	High-power core-edge integrated scenarios for ADC exploration	Kevin Verhaegh	P1-MAST-U-2026
172	Impact of total flux expansion and divertor turbulence on PFR broadening	Peter Ryan	PB
158	Outer target optimisation through poloidal & total flux expansion	Kevin Verhaegh	P1-TCV-2026 P1-MAST-U-2026
160	Multi-machine study of power exhaust in the X-point target configuration	Kenneth Lee	P1-TCV-2026 P1-MAST-U-2026
165	Impurity transport in strongly baffled ADCs	Nicola Lonigro	P1-TCV-2027 P1-MAST-U-2026
174	Core-Divertor Integrated Power Exhaust Study with Impurities	Lingyan Xiang	P1-TCV-2026 P2-MAST-U
163	Effect of magnetic balance, divertor geometry, and fuelling/seeding location on radiation in DN plasmas	Nicola Lonigro	P1-WEST-2026 P2 others
148	ELM and transient buffering in ADCs of AUG, MAST-U, and TCV	Felix Albrecht	P1-AUG-2027 P1-TCV-2027 P2-MAST-U
175	Assess risk of reattachment during lost of DN magnetic balance in various ADCs for future reactors	Lingyan Xiang	P2
169	Dynamic response of ADCs to demonstrate reactor control & scenario integration benefits	Paulo Figueiredo	P1-AUG-2027 P1-TCV-2027 P1-MAST-U-2026

Summary of P1 proposals

	AUG		TCV		MAST-U	WEST
Red indicates highest priority	2026	2027	2026	2027	2026	2026
AUG scenarios	#144, #161, #162, #176, (#177)		#162			
AUG detachment	#150, #151					
AUG advanced scenarios		#143				
AUG physics	#146, #147, #170	#167				
TCV TBLLD			#154, #156, #164, (#173)			
TCV others				#157, #168, (#153)		
MAST-U					#159	
Multimachine – physics			#158, #160, #174	#165	#158, #160, #165	#163
Multimachine – control		#148, #169		#148, #169	#169	
Pulses requested	84 (48)	47	203 (118)	147	109 (40)	32
Provisional shot allocation	45	48	100	110	48	15

Even P1 proposals need to be merged and shot requests to be cut – overall reduction 50%
The requests in the ultimately highest priority category would fill the entire budget without adjustments

Concluding remarks

- Proposals provide **a good basis for addressing all the four objectives** of RT-07
  - ✓ Special focus to be put on continuing the scenario development and different scans on AUG, the TBLLD baffle configuration on AUG, and obtaining a reliable H-mode in ADC configurations on MAST-U
  - ✓ In addition, priority will be given to ITER-relevant investigations (XPR, wall fluxes,…), promising configurations (e.g., XPT), and control and system identification studies
- Strong overbooking on all the devices means that **not even all the P1 proposals can be fully executed**
  - ✓ Many of the proposals need to be combined and piggy-backing to be applied whenever appropriate
  - ✓ Overall, the WPTE priority will be on H-mode, albeit L-mode can be supported if there are links to model validation (work under objective D4)
  - ✓ If the merging exercise done in a clever way, some P2 proposals may have chances in sneaking into the program
- **Comments on individual machines**
  - ✓ On **AUG**, if scenario development proceeds quickly, more time can be devoted to physics studies
  - ✓ On **TCV**, the focus in 2026 will be on TBLLD while most proposals outside of this phase may fall into 2027
  - ✓ On **MAST-U**, the short campaign time exclusively in 2026 makes it very challenging to complete even the P1 program