5th November 2025

Summary of RT08 proposals

M. Baruzzo, V. Igochine

On behalf of WPTE TFLs

M. Baruzzo, V Igochine, D. Keeling, A. Hakola, B. Labit, E. Tsitrone, N. Vianello

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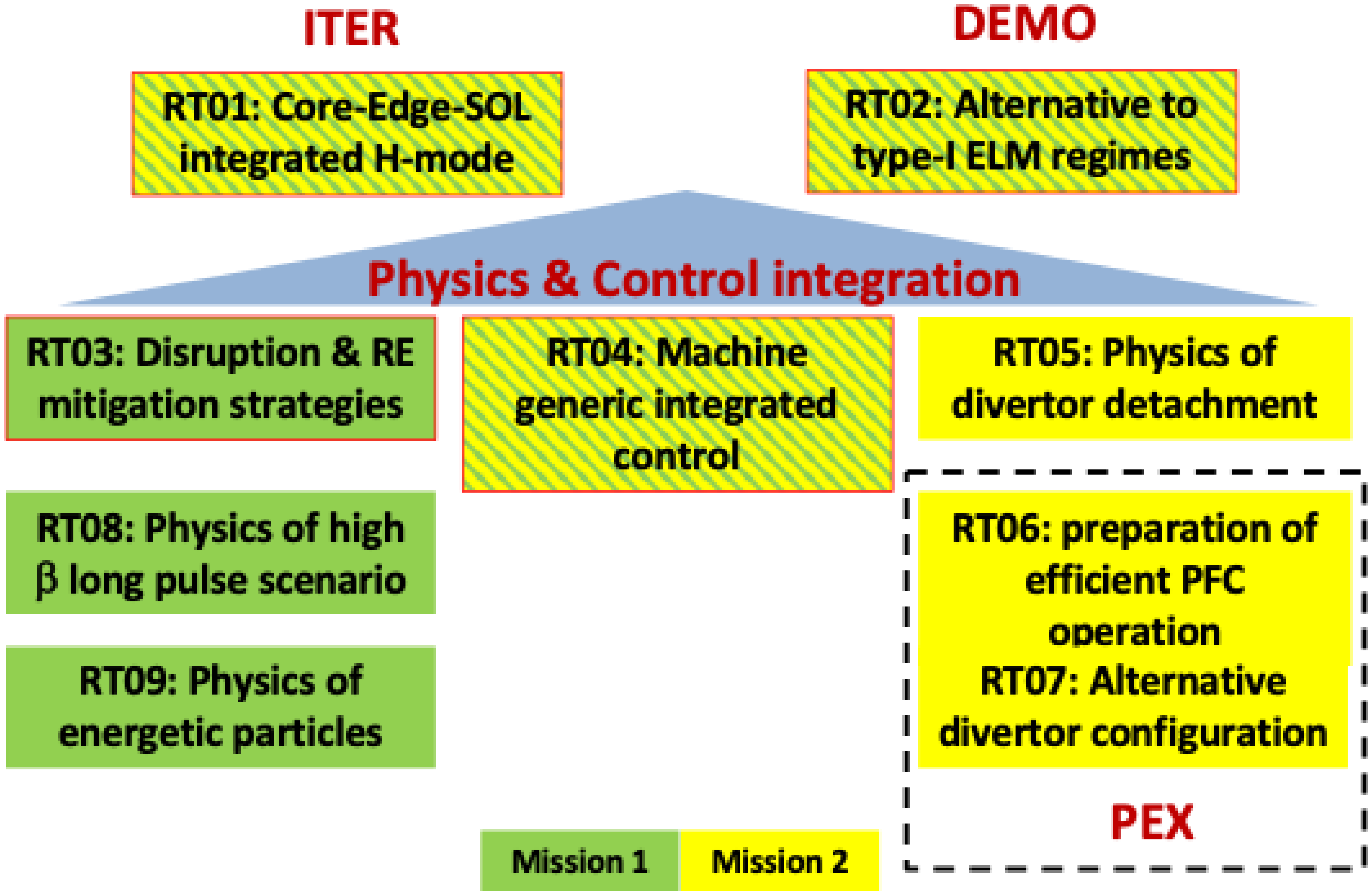
Introduction



Scientific Objectives and Machine Time

#	
D1	Consolidate understanding of flux pumping mechanism and extrapolate to ITER/DEMO/JT-60SA
D2	Quantify compatibility of high βN long-pulse with mitigated ELMs and/or with exhaust in metallic wall devices in view of extrapolating scenario to JT-60SA W-wall operation
D3	Characterize the fast and thermal ion transport together with the ExB, magnetic shear, and turbulence conditions in steady-state scenarios at high-q
D4	Validate state of the art models for scenario extrapolation towards future devices
D5	Develop an intrinsically steady-state solutions at high βN (>3) in terms of q/pressure profile with mild MHD activity. Investigate the dependence of the scenario to the available actuators, and compare it to the expected JT-60SA and DEMO scenarios particularly in terms of extending operational space toward high Gw fractions
D6	Develop steady-state scenarios in metallic devices at high βN in conditions of MHD characteristics close or above the no-wall ideal limit. Investigate the dependence of the scenario to the actuators and characteristics expected to be used in JT-60S

	AUG	TCV	MAST-U	WEST
Tentative allocation 26	32	70	24	15
Tentative allocation 27	16	110		15
Total proposed	100	206	96	145
Scientific/dev.	45/55	116/90	80/16	125/20

Summary of proposals (14)

No	RT	Proposal name	Proposer
178	RT08	Hybrid-like scenario at high βN with 3/2 tearing mode on MAST-U	Gianluca Pucella et al.
179	RT08	Flux pumping studies at low aspect ratio on MAST-U	Sam Blackmore et al
180	RT08	Pushing fast-ion-induced ITBs to the edge for turbulence measurements	Davide Silvagni et al
181	RT08	Hybrid scenario development on MAST-U: current rampup strategies	Fulvio Auriemma et al.
182	RT08	Flux Pumping Parameter Space Determination on AUG	Alexander Bock et al.
183	RT08	EC+IC+LH synergy in view of H-mode and Long Pulse operation in WEST	Ernesto Lerche
184	RT08	Long pulse operation in radiative divertor regime	Remi Dumont et al.
185	RT08	High density, high betap	Christopher Ham et al.
186	RT08	TWA+EC+LH synergy in view of H-mode and Long Pulse operation in WEST	Vincent Maquet
187	RT08	Early Heating Reversed Shear Discharges on AUG	Lea Hollendonner, Alexander Bock et.al.
188	RT08	TWA Bi-Frequency Heating for Long Pulse operation in WEST	Vincent Maquet et al
189	RT08	Development and optimization of high-bootstrap, high-beta tokamak scenarios towards steady-state	Stefano Coda, Chiara Piron, Irina Voitsekhovitch
190	RT08	Study of MHD activities with machine learning in high beta scenarios.	Luca Bonalumi, Edoardo Alessi, Carlo Sozzi
203	RT08	Investigation of internal transport barriers induced on TCV	Sergei Sharapov ← coming from RT09

Summary of proposals (14)

Flux pumping, Hybrid scenario, ITB scenario, Heating synergy

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← coming from RT09

P178: Hybrid-like scenario at high β_N with 3/2 tearing mode on MAST-U

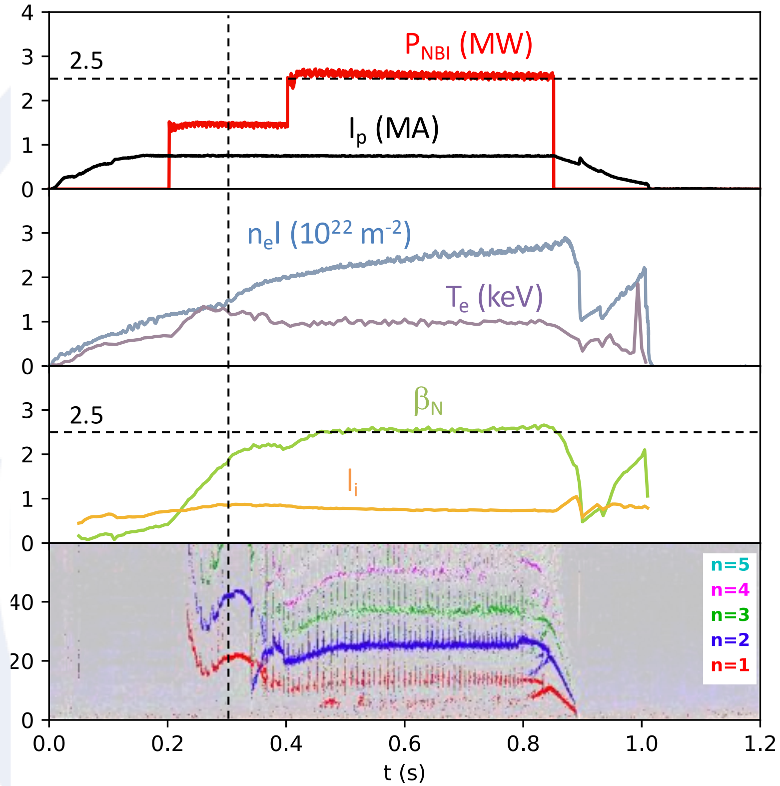
- **Proponents and contact person**

Gianluca Pucella (gianluca.pucella@enea.it)
Fulvio Auriemma, Edmondo Giovannozzi, Francesco Orsitto, Chiara Piron, Luca Senni, Sam Blackmore, Daniele Brunetti, Luca Garzotti, …

- **Scientific background & Objectives**

Recent experiments on MAST-U allowed to obtain a hybrid-like scenario at relatively high beta values (β_N =2.5-2.6) with mild MHD activity (3/2 tearing mode).

  - Determine the β_N threshold for 3/2 mode destabilization in heated pulses without IREs during the Ohmic ramp-up phase (dI_p/dt = 3 MA/s)
  - Investigate the possible flux-pumping mechanism with the 3/2 mode
  - Investigate the possible existence of an upper limit in β_N to avoid the destabilization of a 2/1 mode in the second half of the pulse
  - Dependence of the maximum β_N achievable as function of B_T and I_p



- **Experimental strategy/Machine constraints and diagnostic**
  - On-axis NBI power scan (0.5-2.0 MW), with $t_{inj} \approx$ 200 ms
  - Off-axis NBI power scan (0.5-2.0 MW), with $t_{inj} \approx$ 400 ms, in pulses with on-axis NBI (1.5-2.0 MW) from 200 ms and stationary 3/2 mode
  - I_p < 1.0 MA ("overshoot" in pulses at lower I_p tbc), B_T < 0.7 MA, 1-4 MW NBI
  - SXR, Magnetic pick-up coils, Thomson scattering, Interferometer, MSE

Proposed pulses

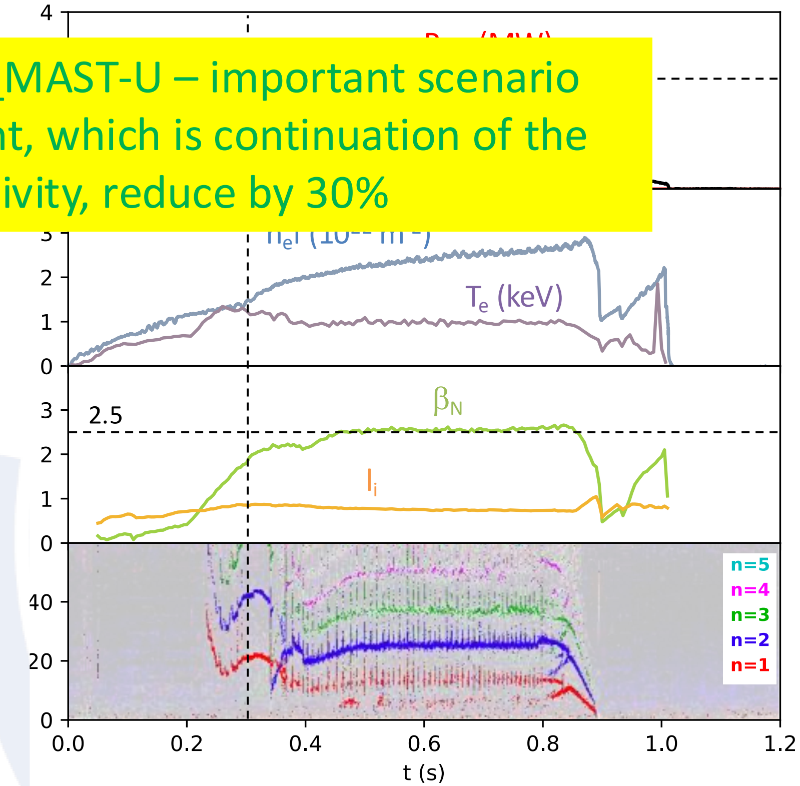
Device	# Pulses/Session	# Development
AUG		
MAST-U	24 / 3	8 / 1
TCV		
WEST		

P178: Hybrid-like scenario at high β_N with 3/2 tearing mode on MAST-U

- ## Proponents and contact person

Gianluca Pucella (gianluca.pucella@enea.it)
Fulvio Auriemma, Edmondo Giovannozzi, Francesco Orsitto, Chiara Piron, Sam Blackmore, Daniele Brunetti, Luca Garzotti, …

Priority: P1_MAST-U – important scenario development, which is continuation of the previous activity, reduce by 30%



- ## Scientific background & Objectives

Recent experiments on MAST-U allowed to obtain a hybrid-like scenario at relatively high beta values (β_N =2.5-2.6) with mild MHD activity (3/2 tearing mode).

- Determine the β_N threshold for 3/2 mode destabilization in heated pulses without IREs during the Ohmic ramp-up phase (dI_p/dt = 3 MA/s)
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- Investigate the possible existence of an upper limit in β_N to avoid the destabilization of a 2/1 mode in the second half of the pulse
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- On-axis NBI power scan (0.5-2.0 MW), with $t_{inj} \approx$ 200 ms
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- I_p < 1.0 MA ("overshoot" in pulses at lower I_p tbc), B_T < 0.7 MA, 1-4 MW NBI
- SXR, Magnetic pick-up coils, Thomson scattering, Interferometer, MSE

Proposed pulses

Device	# Pulses/Session	# Development
AUG		
MAST-U	24 / 3	8 / 1
TCV		
WEST		

P179:Flux pumping studies at low aspect ratio on MAST-U

Proponents: **S. Blackmore**, A. Bock, C. Ham, F. Auriemma
Email: Sam.blackmore@ukaea.uk

Scientific Background & Objectives

Flux pumping (FP) present in MAST-U scenarios via 2/1 tearing mode. Goals for this experiment are to:

- Perform a q95 scan to determine optimal q shear for flux pumping.
- Demonstrate transition from 'non flux pumping' (ie. sawteeth) to 'flux pumping' state, using NBI heating to scan beta poloidal.
- Couple flux pumping core scenario with an alternative divertor solution eg. Super-X, X-point radiator or other concept to demonstrate core-exhaust integration.

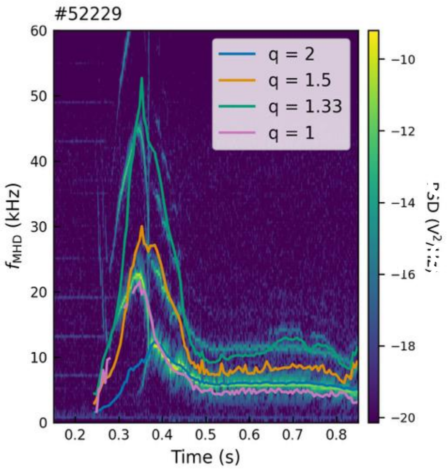
Experimental Strategy

Continue from MU04 internal MHD-04 flux pumping program and RT08 2025 scenario development of 750kA plasma

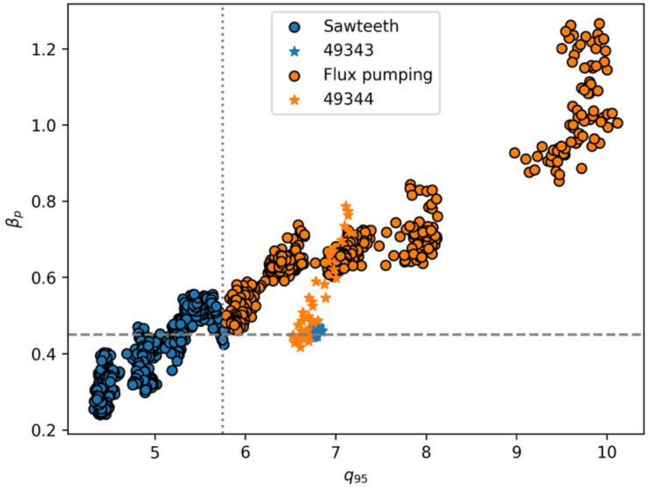
Modify q95 in flux pumping scenario.

Beta poloidal scan using NBI heating.

Establish FP with alternative divertor configuration eg. super-X sweep or inject gas recipe from X point radiator scenario.



MAST-U scenario with 1/1 MHD activity before 2/1 mode is triggered.



q95 vs beta poloidal for various sawtoothing / flux pumping MAST-U pulses – Target q95 ~ 6 and beta pol ~ 0.5

Proposed pulses

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

MAST-U: 3MW NBI, MSE / CXRS / RGB / TS

P179:Flux pumping studies at low aspect ratio on MAST-U

Proponents: **S. Blackmore**, A. Bock, C. Ham, F. Auriemma
Email: Sam.blackmore@ukaea.uk

Scientific Background & Objectives

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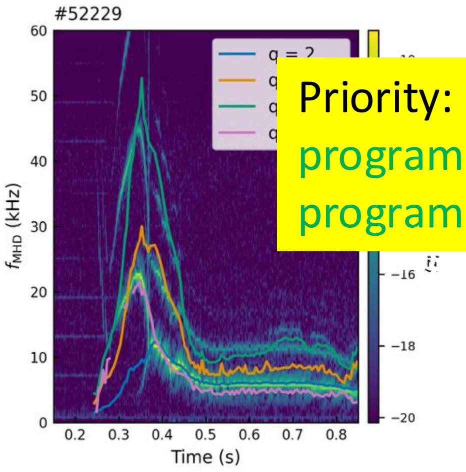

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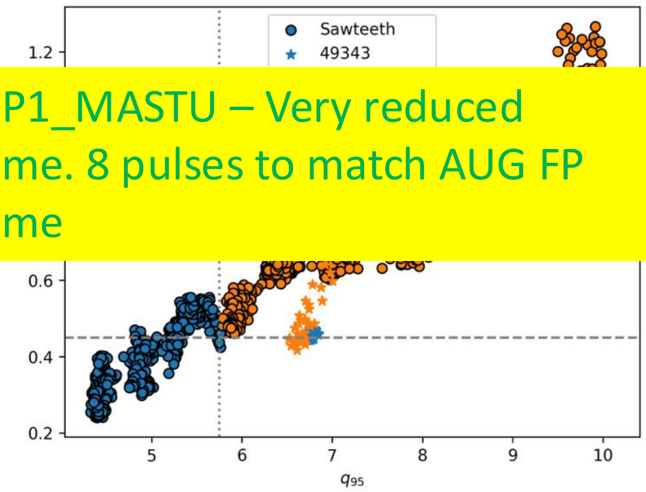


q95 vs beta poloidal for various sawtoothing / flux pumping MAST-U pulses – Target q95 ~ 6 and beta pol ~ 0.5

Priority: P1_MASTU – Very reduced programme. 8 pulses to match AUG FP programme

Proposed pulses

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

MAST-U: 3MW NBI, MSE / CXRS / RGB / TS

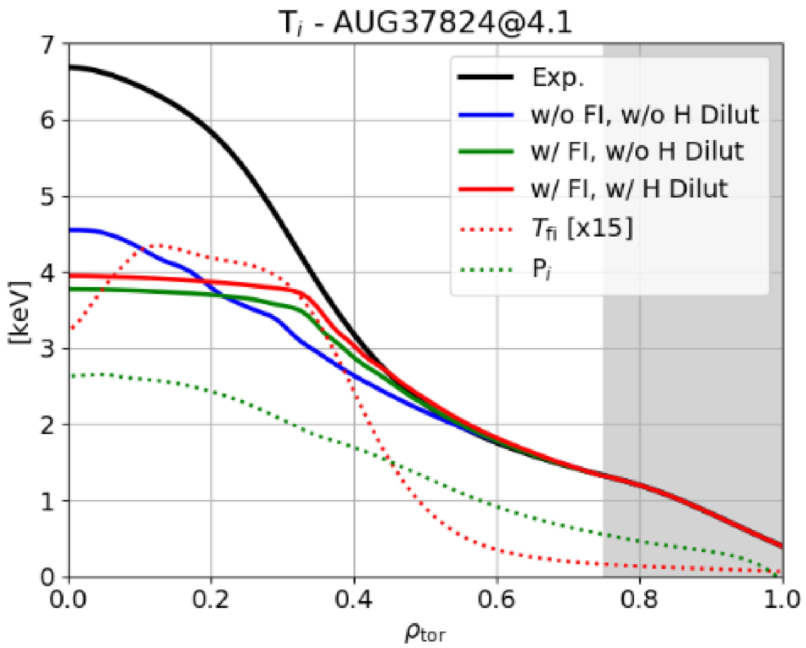
P180: Pushing fast-ion-induced internal transport barriers towards the edge for turbulence measurements

- **Proponents and contact person:**

D. Silvagni, R. Bilato, A. Bock etc. (full list in wiki)

- **Scientific Background & Objectives**
  - Fast ions (FI) can help reducing turbulence in the plasma core and foster ITB formation. However, direct measurement of turbulence characteristics within ITB not possible so far. Goals:
    1. Develop a stable scenario with a fast-ion-induced internal transport barrier (ITB) towards the edge
    2. Measure turbulence characteristics inside the ITB
    3. Compare with gyrokinetic simulations results, to deepen physics understanding and prediction capabilities

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - H(D) minority heating scenario: start from 37824, increase field to move ITB towards edge & find sweet-spot for turbulence measurements (#4)
  - 3He(D) minority heating scenario (only from 2027 as it requires 22 MHz generators): scenario development and optimization for turbulence measurement (#7)
  - Essential diagnostics: Doppler reflectometry and CECE



[Bilato et al. AIP 2023]

Proposed pulses

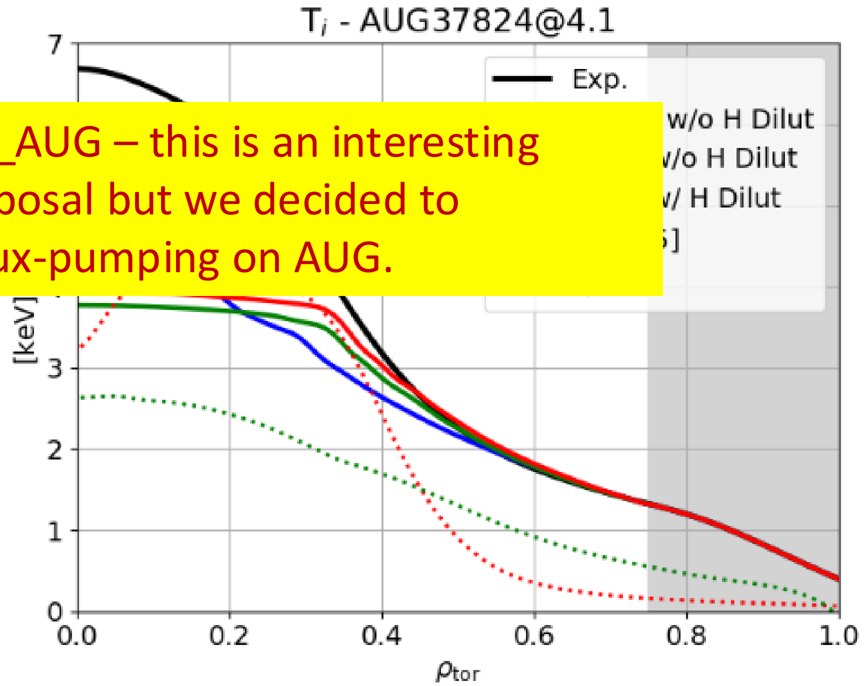
Device	# Pulses/Session	# Development
AUG	4	7
MAST-U		
TCV		
WEST		

P180: Pushing fast-ion-induced internal transport barriers towards the edge for turbulence measurements

- **Proponents and contact person:**

D. Silvagni, R. Bilato, A. Bock etc. (full list in wiki)

Priority: P2_AUG – this is an interesting physics proposal but we decided to prioritize flux-pumping on AUG.



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Proposed pulses

Device	# Pulses/Session	# Development
AUG	4	7
MAST-U		
TCV		
WEST		

- **Experimental Strategy/Machine Constraints and essential diagnostic**
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P 181: Hybrid scenario development on MAST-U: current ramp-up strategies

Proponents and contact person:

F. Auriemma G. Pucella Francesco Paolo Orsitto C. Vincent Luca Senni …

Scientific Background & Objectives

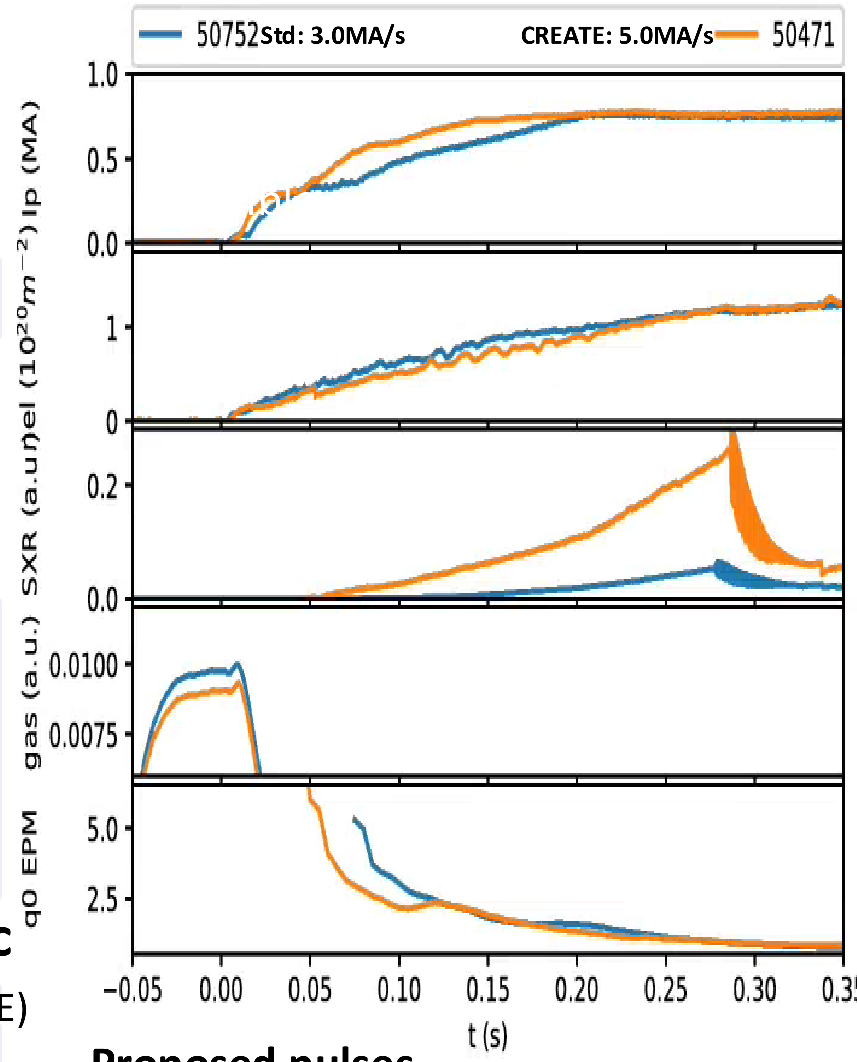
Hybrid-like plasma q profile depends on the current profile evolution during the ohmic ramp-up phase. Good ohmic references obtained in 2024 identifying the (not optimized) ramp-up rate (3.0MA/s)

The proposal aims at optimizing such preliminary results, performing:

- Gas scan at 600kA and 750kA to obtain 2 set of comparable pulses with standard (3.0MA/s) and CREATE-ILC controller
- Development of the current overshoot by means of the CREATE-ILC controller
- Development of an effective strategy to simulate the ramp up:
  - Compute q profile with different resistivity models→ match the evolution of MHD markers

Experimental Strategy/Machine Constraints and essential diagnostic

- From reference pulses 600kA: 50903(std); 51130(CREATE) ;750kA: 50752(std); 50471(CREATE) run the density scan
- 1 session dedicated to current OS technique at 600kA and 750kA of flattop current
- TRANSP/ASTRA analysis of q evolution, comparison with MHD markers as q=1 arrival time ($t_{q=1}$) and q=1 radial position ($R_{q=1}$)



Proposed pulses

Device	# Pulses/session	# Develop.
MAST-U	24/3	

P 181: Hybrid scenario development on MAST-U: current ramp-up strategies

Proponents and contact person:

F. Auriemma G. Pucella Francesco Paolo Orsitto C. Vincent Luca Senni ...

Priority: P2_MAST-U – Large proposal, merge with 178

Scientific Background & Objectives

Hybrid-like plasma q profile depends on the current profile evolution during the ohmic ramp-up phase. Good ohmic references obtained in 2024 identifying the (not optimized) ramp-up rate (3.0MA/s)

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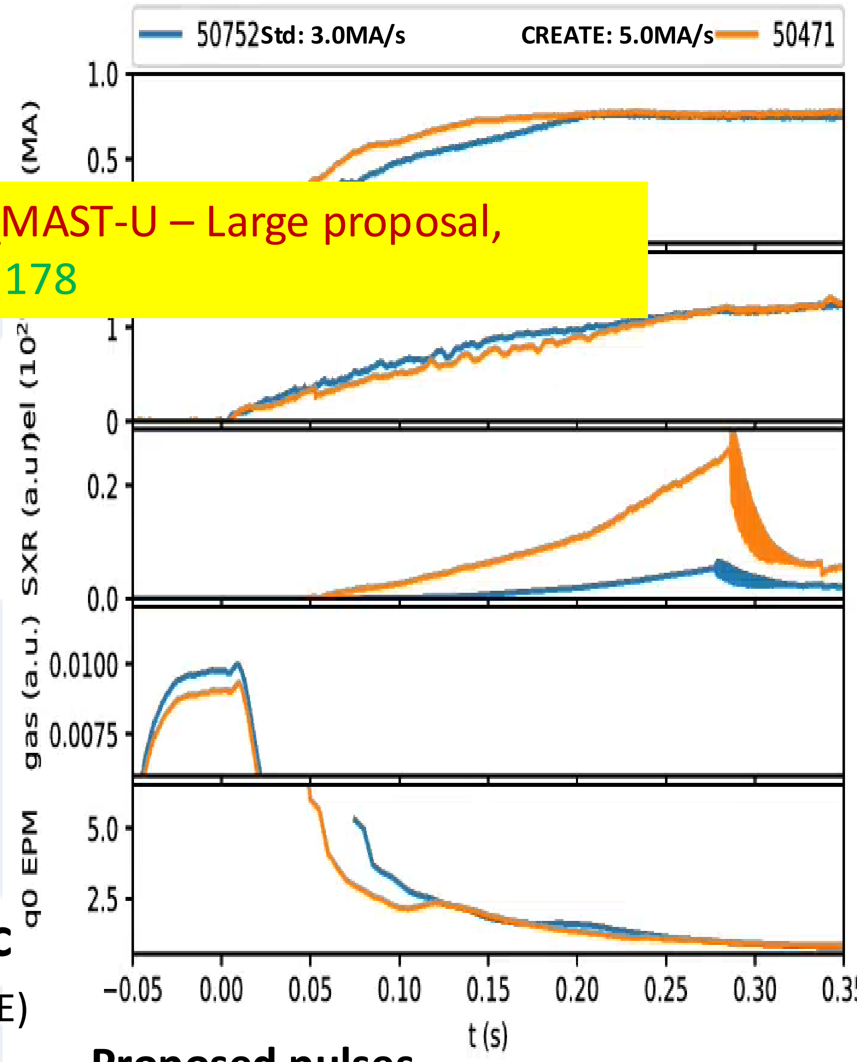

Experimental Strategy/Machine Constraints and essential diagnostic

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- TRANSP/ASTRA analysis of q evolution, comparison with MHD markers as q=1 arrival time ($t_{q=1}$) and q=1 radial position ($R_{q=1}$)

Proposed pulses

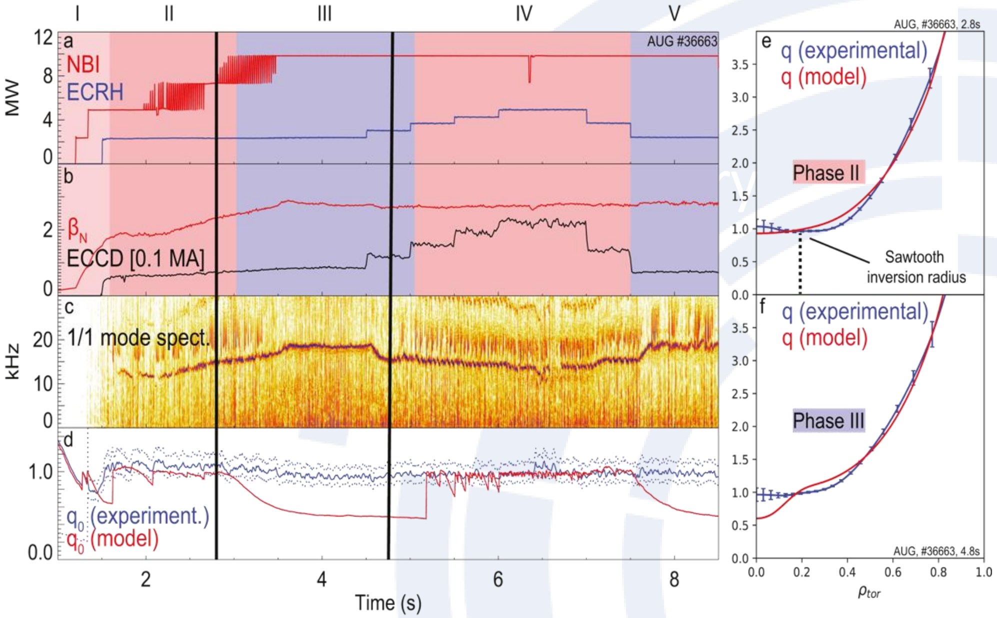
Device	# Pulses/session	# Develop.
MAST-U	24/3	

P182: Investigating 1,1 Flux Pumping Parameter Dependence

- **Proponents and contact person:**
  Alexander Bock alexander.bock@ipp.mpg.de
  A Burckhart, V Igochine, T Pütterich,
  J Stober

- **Scientific Background & Objectives**
  Quantitative knowledge of FP params still lacking, incl. whether β_{N} or β_{pol} is a better proxy for the drive or what ideal/resistive MHD limits exist. These need to be understood for robust extrapolation to future FPPs.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  Scan between existing/potential AUG FP scenarios and, as far as possible, dimensionless parameter-matched reproductions of recent FP JET pulses. Start with ramp-up fueling scans to optimize access to FP regime. Continue with q_{95} scans to discriminate β_{N} and β_{pol}, and also variations of δ. Dedicated comparisons between existing AUG FP pulses with 1,1-mode and fishbones could shed light on the physics differences leading to one or the other.



Proposed pulses

Device	# Pulses/Session	# Development
AUG	25	30
MAST-U		
TCV		
WEST		

Machine req AUG: 15MW NBI, 5MW ECRH, (I)MSE

P182: Investigating 1,1 Flux Pumping Parameter Dependence

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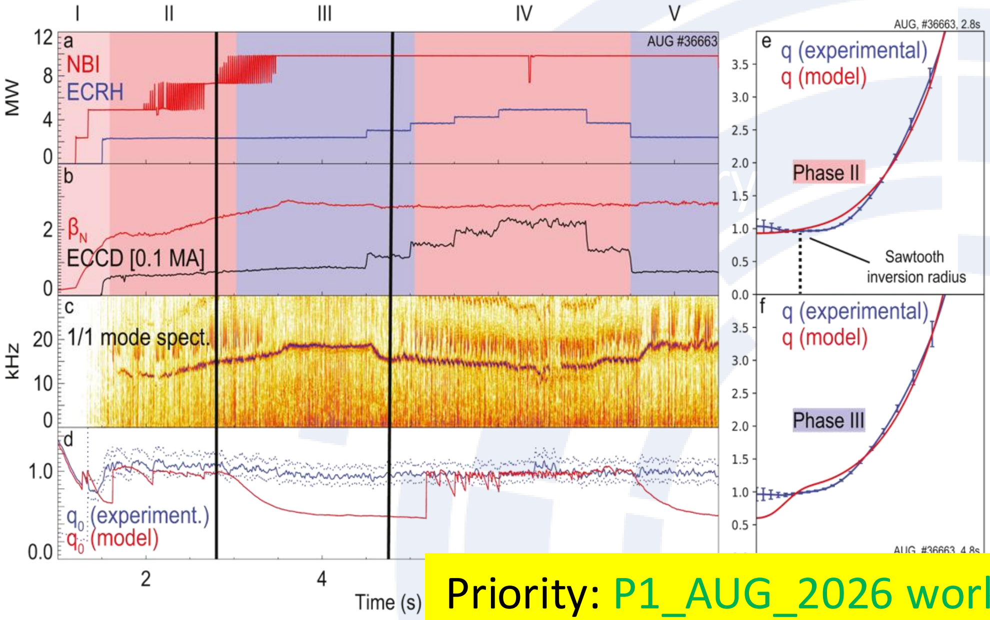


Priority: P1_AUG_2026 work horse proposal for understanding FP

Proposed pulses

Device	# Pulses/Session	# Development
AUG	25	30
MAST-U		
TCV		
WEST		

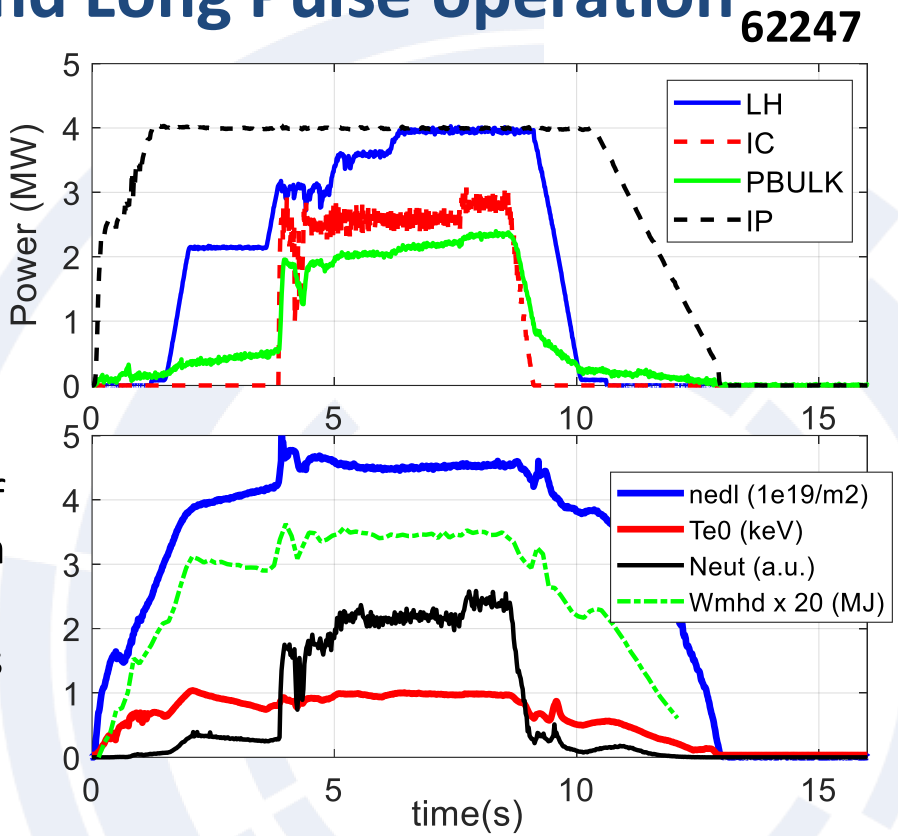
Machine req AUG: 15MW NBI, 5MW ECRH, (I)MSE

183: IC / EC / LH synergy in view of H-mode and Long Pulse operation

- **Proponents and contact person:**
  E. Lerche, X. Litaudon, R. Dumont, J. Hillairet, L. Colas, S. Mazzi, P. Manas, P. Maget, T. Fonghetti, …

- **Scientific Background & Objectives**
  - ICRH works well in WEST (without impurity issues) in high density / low temperature plasmas (cold-branch) but high power LHCD is challenging in these conditions (W radiation, MHD, …)
  - Applying ICRH in the 'hot-branch' discharges is also challenging because of low coupling and interference with the high power LHCD system operation
  - ECRH can help on both strategies, namely avoiding W accumulation and MHD (flatter q-profile) when starting in the 'cold-branch' and allowing less LHCD power request to reach the hot-branch (potentially larger ICRH)
  - Objectives:
  - Develop a high-performance discharge with combined ECRH+ICRH+LHCD
  - Determine best heating mix and heating sequence
  - Potentially achieve H-mode with extra 1-2 MW of ECRH
  - Contribute to increase the performance of the t>1000s long pulses with efficient hating mix

- **Exp. Strategy/Machine Constraints and diagnostics**
  - Start from known plasma scenarios in the 'cold-branch' and in the 'hot-branch' and change the heating sequence to find the best recipe for optimal operation ('W burn-through', minimize MHD, etc.)
  - All heating systems to be fully operational
  - Standard diagnostics for plasma performance (focus on core physics); Accurate H minority control



Example of WEST discharge with P_{sep} close to $P_{L\text{-}H}$ power threshold (LH+IC=6.5MW)

Proposed pulses

Device	# Pulses/Session	# Development
WEST	2 Sessions (with full power)	1 session for scenario development + heating set-up

183: IC / EC / LH synergy in view of H-mode and Long Pulse operation

- **Proponents and contact person:**

  E. Lerche, X. Litaudon, R. Dumont, J. Hillairet, L. Colas, S. Mazzi, P. Manas, P. Maget, T. Fonghetti, …

- **Scientific Background & Objectives**
  - ICRH works well in WEST (without impurity issues) in high density / low temperature plasmas (cold-branch) but high power LHCD is challenging in these conditions (W radiation, MHD, …)
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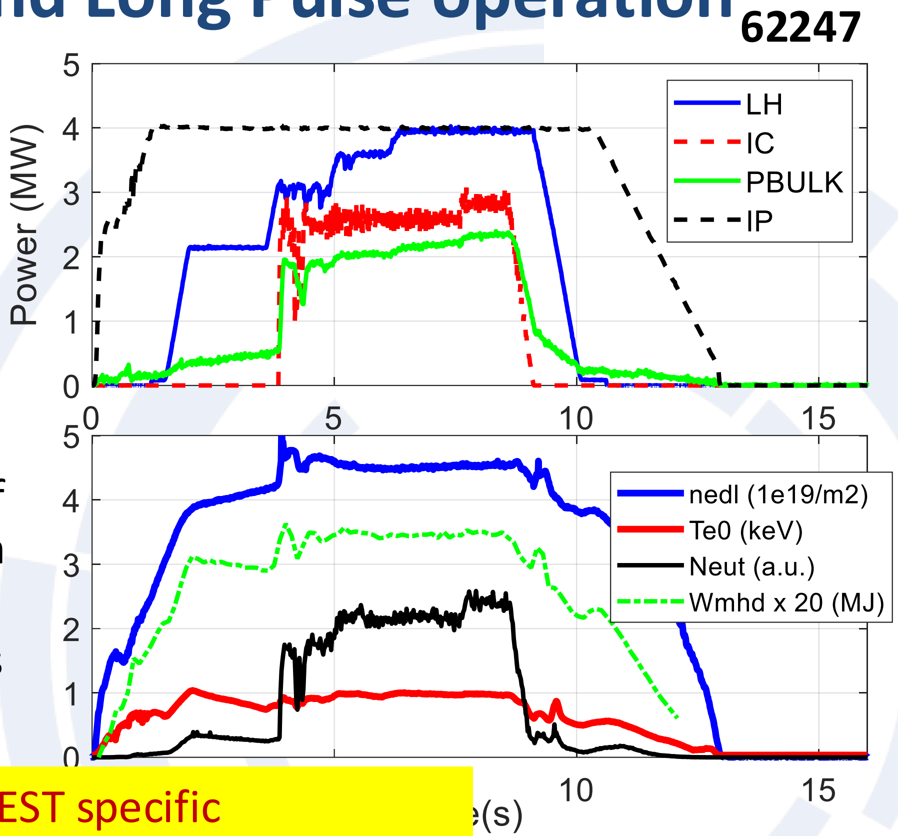


Priority: P2_WEST. WEST specific

Example of WEST discharge with P_{sep} close to $P_{L\text{-}H}$ power threshold (LH+IC=6.5MW)

- **Exp. Strategy/Machine Constraints and diagnostics**
  - Start from known plasma scenarios in the ‘cold-branch’ and in the ‘hot-branch’ and change the heating sequence to find the best recipe for optimal operation (‘W burn-through’, minimize MHD, etc.)
  - All heating systems to be fully operational
  - Standard diagnostics for plasma performance (focus on core physics); Accurate H minority control

Proposed pulses

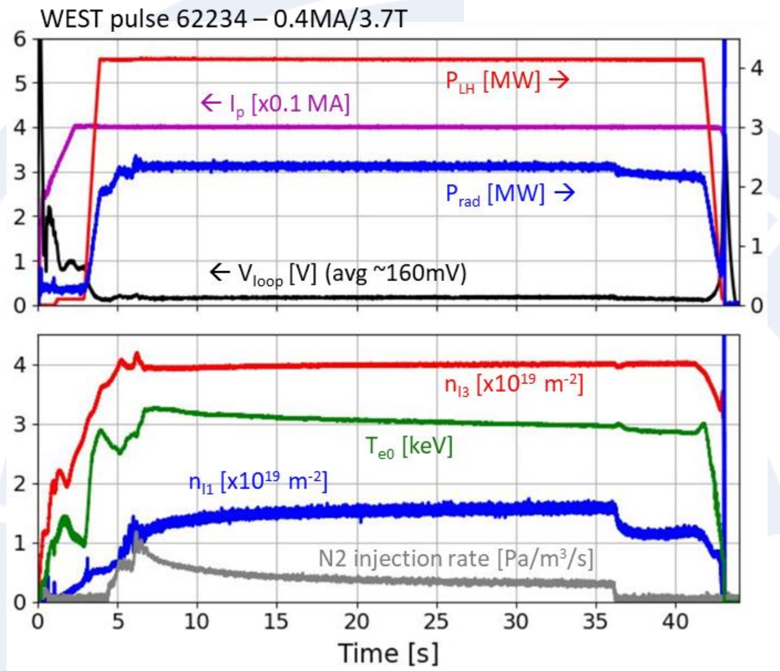
Device	# Pulses/Session	# Development
WEST	2 Sessions (with full power)	1 session for scenario development + heating set-up

P184: Long pulse operation in radiative divertor regime

- **Proponents and contact person:**
  - R. Dumont (remi.dumont@cea.fr), P. Maget , P. Manas, N. Fedorczak, A. Fil, T. Fonghetti, P. Forestier-Colleoni, J. Gunn, E. Lerche, J. Morales, N. Rivals

- **Scientific Background & Objectives**
  - **Background**
    - Radiative divertor regime required to prevent UFO events on long plasma durations
    - Demonstrating a fully controlled radiative divertor regime on long durations is challenging
    - Achieving high performance (high β) in XPR/low loop voltage pulses requires optimization
    - Development work in detached regime has already started within RT08
    - Challenges to address:
      - N2 injection rate optimization
      - XPR transition identification at low plasma currents
      - LHCD efficiency optimization (could be compensated by confinement improvement)
  - **Objectives**
    - Extend fully non-inductive scenarios to XPR regimes
      - Demonstrate RT control of loop voltage in the presence of controlled N2 (or Ne) injection to maintain XPR at low currents
      - Qualify confinement, W sources and contamination. Compare to attached regime
    - Maximize performance of detached steady-state pulses
      - Continue ramp-up/current profile optimizations
      - Apply ECRH/CD to enlarge parameter space
      - Test Ne injection (better exhaust than N_2), depending on progress on XPR developments in internal program & RT05 (divertor detachment)), RT06 (PFC testing, high fluence)

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Reference pulse : WEST pulse 62234 (V_{loop}~160 mV) - LSN plasma with LHCD, N_2 seeding
    - Decrease current, add ECRH/ECCD
    - For each value of current, test various levels of N2 injection in feed-forward
      - several plateaus in development pulses, checking XPR transitions using Langmuir probes
    - Once adequate N2 level determined for a given current, go to feedback control on edge interf. measurement
    - Scans in plasma current, electron density, …
  - Essential diagnostics: SXR, HXR, XICS, visible and VUV spectroscopy, **Langmuir probes**



Overview of XPR pulse 62234 (V_{loop}~160 mV)

Proposed pulses

Device	# Pulses/Session	# Development
AUG		
MAST-U		
TCV		
WEST	40/2	20

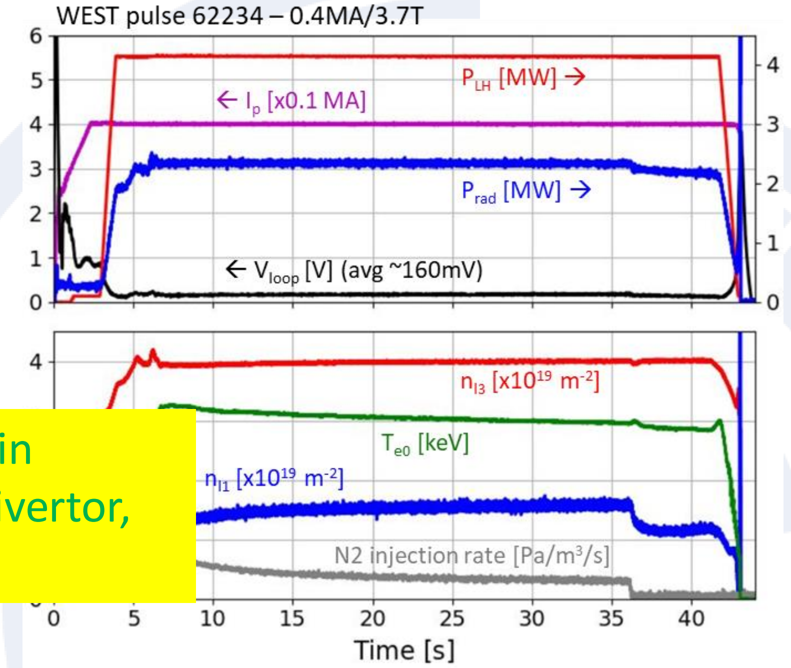
P184: Long pulse operation in radiative divertor regime

- **Proponents and contact person:**
  - R. Dumont (remi.dumont@cea.fr), P. Maget , P. Manas, N. Fedorczak, A. Fil, T. Fonghetti, P. Forestier-Colleoni, J. Gunn, E. Lerche, J. Morales, N. Rivals

- **Scientific Background & Objectives**
  - **Background**
    - Radiative divertor regime required to prevent UFO events on long plasma durations
    - Demonstrating a fully controlled radiative divertor regime on long durations is challenging
    - Achieving high performance (high β) in XPR/low loop voltage pulses requires optimization
    - Development work in detached regime has already started within RT08
    - Challenges to address:
      - N2 injection rate optimization
      - XPR transition identification at low plasma currents
      - LHCD efficiency optimization (could be compensated by
  - **Objectives**
    - Extend fully non-inductive scenarios to XPR regimes
      - Demonstrate RT control of loop voltage in the presence of controlled N2 (or Ne) injection to maintain XPR at low currents
      - Qualify confinement, W sources and contamination. Compare to attached regime
    - Maximize performance of detached steady-state pulses
      - Continue ramp-up/current profile optimizations
      - Apply ECRH/CD to enlarge parameter space
      - Test Ne injection (better exhaust than N_2), depending on progress on XPR developments in internal program & RT05 (divertor detachment)), RT06 (PFC testing, high fluence)

Priority: P1_WEST unique Proposal in bridging long pulse with radiative divertor, reduce of 40%

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Reference pulse : WEST pulse 62234 (V_{loop}~160 mV) - LSN plasma with LHCD, N_2 seeding
    - Decrease current, add ECRH/ECCD
    - For each value of current, test various levels of N2 injection in feed-forward
      - several plateaus in development pulses, checking XPR transitions using Langmuir probes
    - Once adequate N2 level determined for a given current, go to feedback control on edge interf. measurement
    - Scans in plasma current, electron density, …
  - Essential diagnostics: SXR, HXR, XICS, visible and VUV spectroscopy, **Langmuir probes**



Overview of XPR pulse 62234 (V_{loop}~160 mV)

Proposed pulses

Device	# Pulses/Session	# Development
AUG		
MAST-U		
TCV		
WEST	40/2	20

P185: High density, high β_p scenario

- **Proponents and contact person:**
  Christopher.Ham@ukaea.uk, Chiara Piron, Stefano Coda, Fulvio Auriemma, Alex Bock, Olivier Sauter
- **Scientific Background & Objectives**
  - Increase plasma performance
  - (high β_p) on MAST-U and TCV and show that very high Greenwald fraction is possible. Recent DIII-D experiments have shown high β_p exists with high density. This is very power plant relevant
  - P1 proposal in 2025. Initial work on MAST-U showed route to higher power density with USN. Initial work on TCV had significant MHD which is being worked on.
  - Establish this regime on AUG. Support ITPA-IOS JEX3.2
- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - In MAST-U use USN to reduce plasma volume and increase power density, then increase density with early on-axis NBI
  - In TCV reduce plasma current from initial attempts and optimise ECRH heating. Use Raptor modelling to assist scenario development
  - In AUG develop scenario

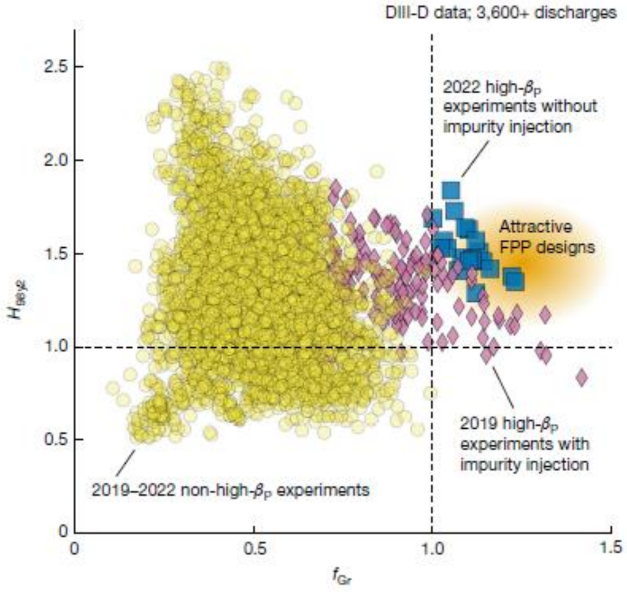


Fig. 1 | Database of H_{98y2} and f_{Gr} for DIII-D discharges. More than 3,600 discharges are included. Violet diamonds show high-β_p experiments performed in 2019 with impurity injection. Blue squares are the new high-β_p experiments performed in 2022 without impurity injection. Yellow circles represent all other experiments performed in 2019–2022. The area shaded in orange indicates the parameter space for attractive FPP designs. Vertical and horizontal dashed lines show $f_{Gr} = 1.0$ and $H_{98y2} = 1.0$, respectively.

Ding, S., Garofalo, A.M., Wang, H.Q. *et al.* A high-density and high-confinement tokamak plasma regime for fusion energy. *Nature* **629**, 555–560 (2024).

Proposed pulses

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

P185: High density, high β_p scenario

- **Proponents and contact person:**
  Christopher.Ham@ukaea.uk, Chiara Piron, Stefano Coda, Fulvio Auriemma, Alex Bock, Olivier Sauter
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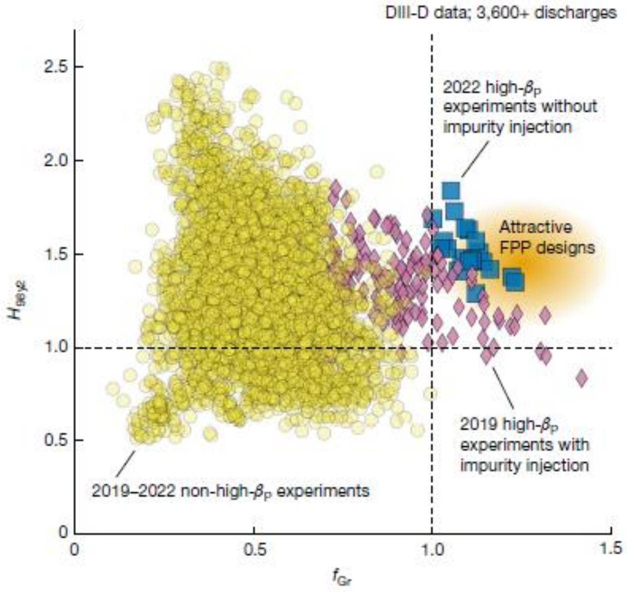
  - In TCV reduce plasma current from initial attempts and optimise ECRH heating. Use Raptor modelling to assist scenario development
  - In AUG develop scenario

Priority: P2-AUG, P1-TCV, P2-MAST-U, no budget for MAST-U. pursued in internal campaign



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Proposed pulses

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

P186: TWA EC LH synergy

- **Proponents**
- **V. Maquet**, R. Ragona, J. Hillairet, E. Lerche, X. Litaudon, R. Dumont, L. Colas, D. Van Eester, S. Mazzi, P. Manas, P. Maget, T. Fonghetti, P. Dumortier, et al.
- **Scientific Objectives**
- The WEST TWA consists of 2 strap arrays stacked on top of each other, fed by two independant generators with possibly two different RF frequencies. Each array features a narrow $k_{//}$ spectrum, allowing localized frequency-dependant power deposition.
- Goal: Develop a high-performance discharge with the combined power capabilities of TWA/ECRH/LHCD.

Experimental Strategy

- Start from known plasma scenarios ("cold" and "hot" branch) and find recipe for a high-performance discharge with the combined power capabilities of TWA/ECRH/LHCD.
- All heating system to be fully operational.
- Standard diagnostics for plasma performance control monitoring and accurate H minority control.

- **Expected Outcomes**
  - Compare plasma performances with different heating mix and sequences.
  - Find optimal recipe.
  - Validate predictive modelling.

P186: TWA EC LH synergy

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- **V. Maquet**, R. Ragona, J. Hillairet, E. Lerche, X. Litaudon, R. Dumont, L. Colas, D. Van Eester, S. Mazzi, P. Manas, P. Maget, T. Fonghetti, P. Dumortier, et al.
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- **Expected Outcomes**
  – Compare plasma performances with different heating mix and sequences.
  – Find optimal recipe.
  – Validate predictive modelling.

Priority: P2_WEST. WEST specific

P187: Extend the negative magnetic shear region in early-heating scenarios on AUG

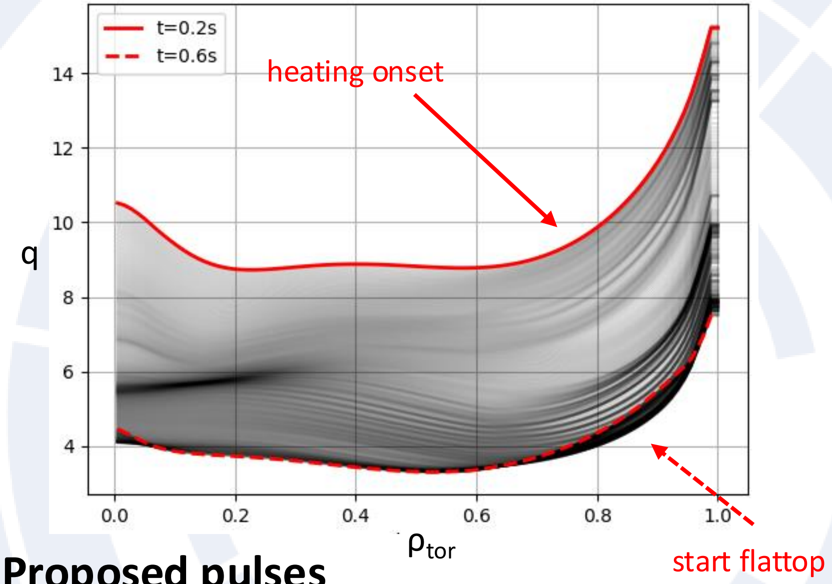
- **Proponents and contact person:**
  - Lea.Hollendonner@ipp.mpg.de
  - Alexander.Bock@ipp.mpg.de

- **Scientific Background & Objectives**
  - Study the relation between ITBs and magnetic shear
  - Extended regions of negative shear can be achieved with early off-axis heating (limitation: X-point formation)

- **Experimental Strategy**
  - **Early X-point formation** for early heating onset
  - **Off-axis heating** by ECRH to reduce current diffusion into the core
  - **On-axis counter-ECCD** to actively remove current from the core (and prevent tungsten accumulation)

- **Diagnostics and Machine Technical requirements**
  - IMSE
  - co-/counter-ECCD, NBI

First simulations in ASTRA explore the effect of early off-axis ECRH on the q-profile evolution



Proposed pulses

Device	# Pulses/Session	# Development
AUG	0	18
MAST-U		
TCV		
WEST		

P187: Extend the negative magnetic shear region in early-heating scenarios on AUG

Priority: P2_AUG. Technically difficult.
Current hole inherently difficult to control

- **Proponents and contact persons**
  - Lea.Hollendonner@ipp.mpg.de
  - Alexander.Bock@ipp.mpg.de

- **Scientific Background & Objectives**
  - Study the relation between ITBs and magnetic shear
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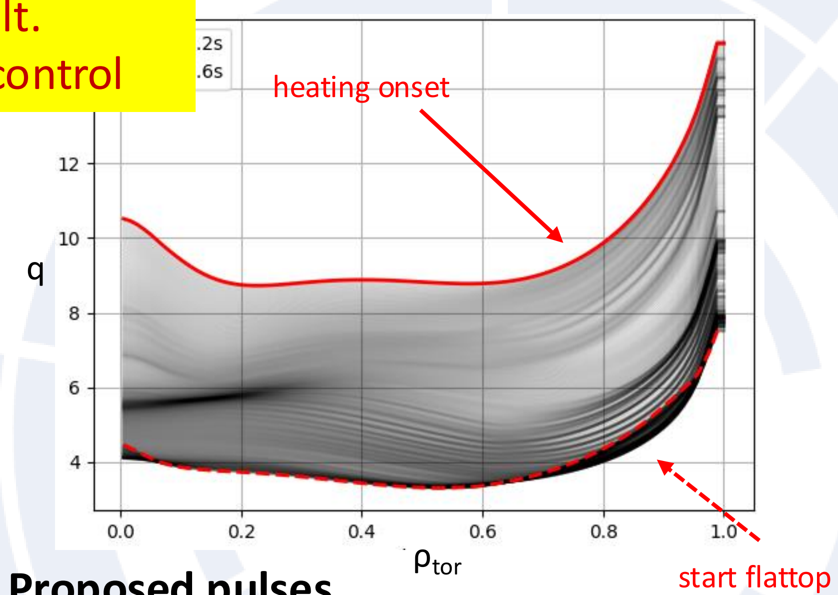


Proposed pulses

Device	# Pulses/Session	# Development
AUG	0	18
MAST-U		
TCV		
WEST		

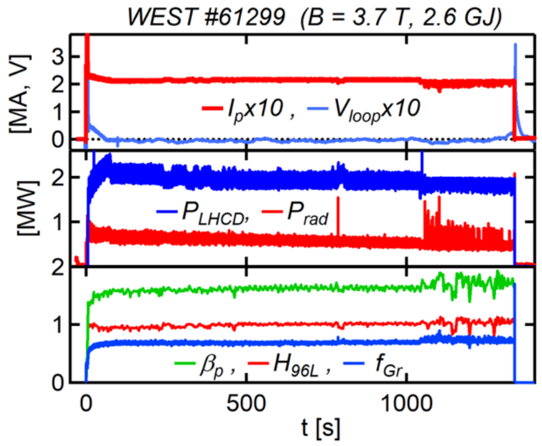
P188: TWA dual-frequency sweep for long pulse operation in WEST

- **Proponents and contact person:**

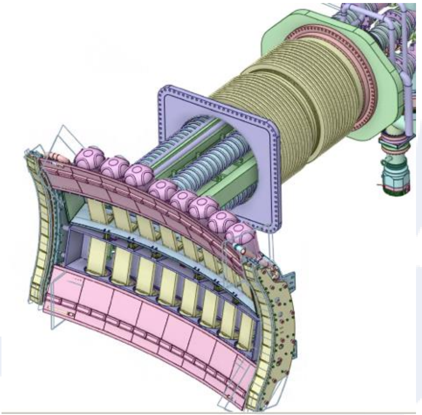
Riccardo Ragona, Vincent Maquet, Julien Hillairet, Ernesto Lerche, et al (see full list on wiki)

- **Scientific Background & Objectives**

  - ❖ WEST record pulse #61299 identified the need for MHD control, in steady state, to allow increasing β.
  - ❖ ECCD is a valuable candidate to provide this functionality
  - ❖ ICRH could also contribute with an innovative launcher (Travelling Wave Array) and operation scheme (frequency sweeping), potentially delivering core heating with reduced fast ion losses
  - ❑ The aim is to investigate the effects of ICRF on preventing MHD during long pulse operation in metallic wall devices (*D3*).
  - ❑ The main objective is to develop a steady-state solution for MHD control (*D5*), based on ICRH, in WEST long pulses conditions (ref. #61299).
  - ❑ Specifically, to demonstrate for the first time the use of frequency sweeping for power deposition tailoring, allowing to investigate possible control strategies.
  - ❑ An additional objective is to contribute to multi-machine database for model validation (*D4*).



- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Develop scenario for optimal IC frequency sweep Ref. #61299, short pulses (10 s).
    - TWA rows different freq. for central heating
    - Scan sweeping amplitude in step (1-4 MHz)
    - Compare with static dual-frequency
    - Power modulation / BiS to assess power flow while monitoring impurities
  - Extend to 1000 s
  - Main diagnostics for plasma performance
    - As for long pulses, focus on core performance, accurate H minority concentration



Proposed pulses

Device	# Pulses/Session	# Development
AUG		
WEST	1.5 session (2027) + 2/3 long discharges	

P188: TWA dual-frequency sweep for long pulse operation in WEST

- **Proponents and contact person:**

Riccardo Ragona, Vincent Maquet, Julien Hillairet, Ernesto Lerche, et al (see full list on wiki)

- **Scientific Background & Objectives**

  - ❖ WEST record pulse #61299 identified the need for MHD control, in steady state, to allow increasing β.
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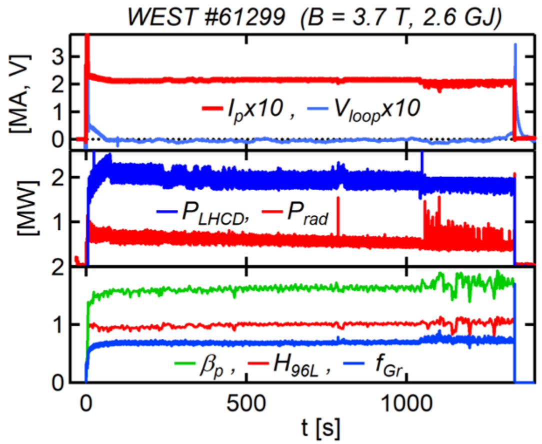
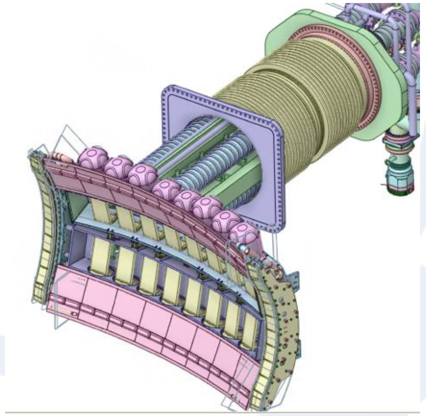




- **Experimental Strategy/Machine Constraints and essential dia**

Priority: P2_WEST. WEST specific

  - Develop scenario for optimal IC frequency sweep Ref. #61299, short pulses (10 s).
    - TWA rows different freq. for central heating
    - Scan sweeping amplitude in step (1-4 MHz)
    - Compare with static dual-frequency
    - Power modulation / BiS to assess power flow while monitoring impurities
  - Extend to 1000 s
  - Main diagnostics for plasma performance
    - As for long pulses, focus on core performance, accurate H minority concentration

Proposed pulses

Device	# Pulses/Session	# Development
AUG		
WEST	1.5 session (2027) + 2/3 long discharges	

189: Development and optimization of high-bootstrap, high-beta tokamak scenarios towards steady state

- **Proponents and contact person:**

S. Coda, C. Piron, I. Voitsekhovitch

- **Scientific Background & Objectives**

This proposal extends the work done at TCV within WPTE RT08 in 2024/25 [WPTE-RT08 Review Meeting]

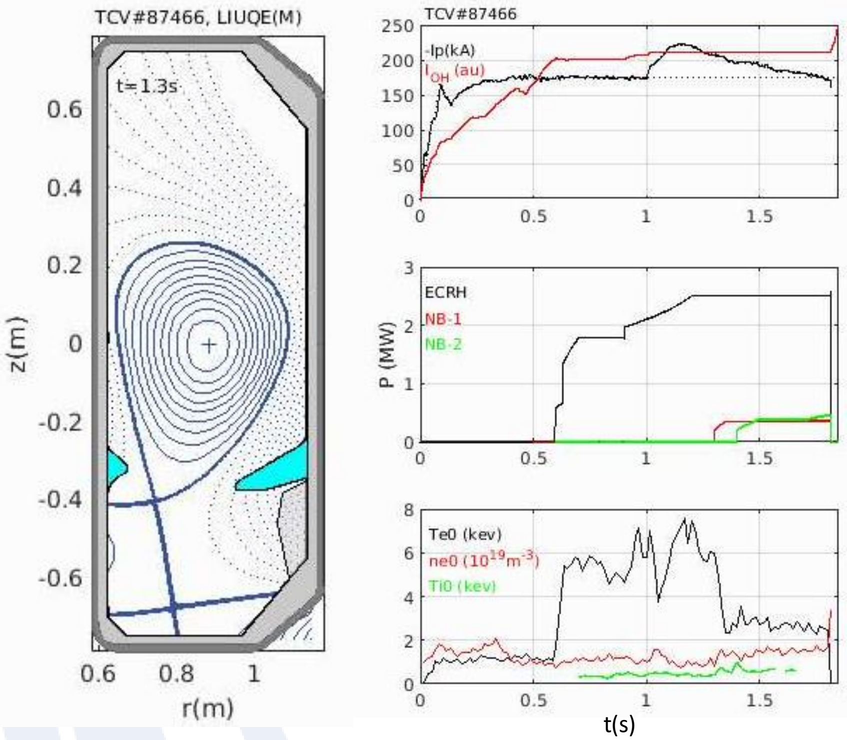
- ❑ Identify maximum achievable betaN in fully non-inductive mode and in stationary conditions with the additional ECRH power that will be available.
- ❑ Explore parameter space to determine whether, for equal betaN, steeper gradients can be achieved to increase bootstrap current fraction.
- ❑ Achieve CS-free operation from the RU to the end of FT with the maximum possible plasma current and maximum possible betaN, enabling the NBI operation with the minimised fast-ion losses.
- ❑ Demonstrate CS-free exhaust-compatible operation in the X-point Target Radiator configuration, and document core transport and confinement relative to the previously standard LSN configuration.
- ❑ Validate transport models in reversed/low-shear plasmas and identify the dominant micro-instabilities controlling the anomalous transport in such configurations.
- ❑ Fully document roles of fast electrons and fast ions in long-pulse scenarios developed, as well as scrape-off layer characteristics (width, fluctuations, etc).

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

- ❑ Optimize shape and ECCD deposition to reach Ip>130kA in CS-free RU scenario in LSN. Develop a similar CS-free RU scenario in XPTR.
- ❑ Fine-tune the heating recipe in the 2025 CS-free FT scenario in XPTR to avoid MHD. Verify if detachment can accessed in this scenario.
- ❑ Exploit the additional P_{EC}=0.95MW from G12 for scenario development and MHD control

NINO/SILO configuration, P_{EC}=2.6(+0.95)MW + $P_{NB-[1,2]}$=2.6MW

Essential diagnostics: TS, MAG, CXRS, cECE, TPCI, FIDA, SPR, THB, LPs, IR, MSE



Proposed pulses

Device	# Pulses/Session	# Development
AUG		
MAST-U		
TCV	80	80
WEST		

189: Development and optimization of high-bootstrap, high-beta tokamak scenarios towards steady state

- **Proponents and contact person:**

S. Coda, C. Piron, I. Voitsekhovitch

- **Scientific Background & Objectives**

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- ❑ Identify maximum achievable betaN in fully non-inductive mode and in stationary conditions with the additional ECRH power that will be available.
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- ❑ Achieve CS-free operation from the RU to the end of FT with the maximum possible plasma current and maximum possible betaN, enab[...] minimised fast-ion losses.
- ❑ Demonstrate CS-free exhaust-compatible operation [...] configuration, and document core transport and confinement relative to the previously standard LSN configuration.
- ❑ Validate transport models in reversed/low-shear plasmas and identify the dominant micro-instabilities controlling the anomalous transport in such configurations.
- ❑ Fully document roles of fast electrons and fast ions in long-pulse scenarios developed, as well as scrape-off layer characteristics (width, fluctuations, etc).

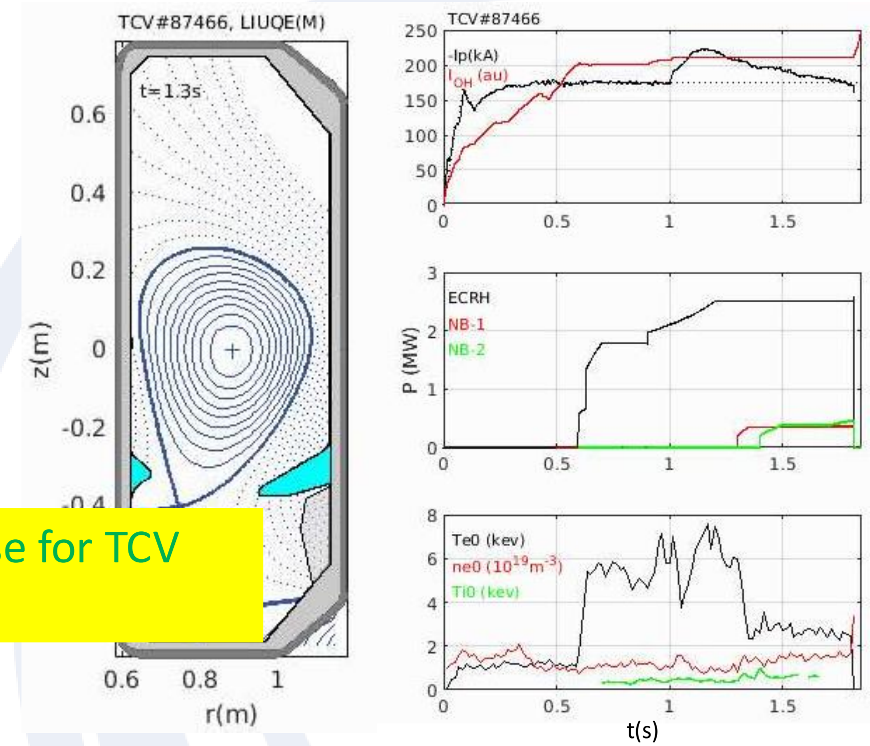
Priority: P1-TCV, main work horse for TCV non inductive scenario

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

- ❑ Optimize shape and ECCD deposition to reach Ip>130kA in CS-free RU scenario in LSN. Develop a similar CS-free RU scenario in XPTR.
- ❑ Fine-tune the heating recipe in the 2025 CS-free FT scenario in XPTR to avoid MHD. Verify if detachment can accessed in this scenario.
- ❑ Exploit the additional P_{EC}=0.95MW from G12 for scenario development and MHD control

NINO/SILO configuration, P_{EC}=2.6(+0.95)MW + $P_{NB-[1,2]}$=2.6MW

Essential diagnostics: TS, MAG, CXRS, cECE, TPCI, FIDA, SPR, THB, LPs, IR, MSE



Proposed pulses

Device	# Pulses/Session	# Development
AUG		
MAST-U		
TCV	80	80
WEST		

P190: Study of MHD activities with machine learning in high beta scenarios.

Proposed pulses

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

- **Proponents and contact person:**

- Luca Bonalumi (luca.bonalumi@istp.cnr.it)
- Edoardo Alessi
- Carlo Sozzi
- Edmondo Giovannozzi

- **Scientific Background & Objectives**

- Neural networks shown potential in predicting tearing mode triggering probability (tearability) starting from snapshot representing the plasma state
- Interpreting network's behavior can provide physical insight, revealing key parameters that precede the instability and are hidden by the black-box nature of neural networks

Aim of the present proposal is to:

- Compare the network behavior across different devices to highlight possible physical differences in the triggering mechanisms of NTMs.
- Assess how far the interpretation of tearability can be generalized to other machines (JT-60SA), offering insights for high-β studies

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - **Development** of the network for tearability
  - Train **two** separate NNs for high beta scenarios in **TCV** and in **AUG**
  - Evaluate the **reliability** of the NNs
  - **Interpret** the behavior of the NNs (**XAI**, eXplainable Artificial Intelligence; L. Bonalumi et al. *Front.Phys.* 12 2024)
  - **Extrapolate** results for **JT-60SA** high beta scenario

P190: Study of MHD activities with machine learning in high beta scenarios.

Proposed pulses

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

- **Proponents and contact person:**

- Luca Bonalumi (luca.bonalumi@istp.cnr.it)
- Edoardo Alessi
- Carlo Sozzi
- Edmondo Giovannozzi

- **Scientific Background & Objectives**

- Neural networks shown potential in predicting tearing mode triggering probability (tearability) starting from snapshot representing the plasma state
- Interpreting network's behavior can provide physical insight, revealing key parameters that precede the instability and are hidden by the black-box nature of neural networks

Priority: Parasitic

Aim of the present proposal is to:

- Compare the network behavior across different devices to highlight possible physical differences in the triggering mechanisms of NTMs.
- Assess how far the interpretation of tearability can be generalized to other machines (JT-60SA), offering insights for high-β studies

- **Experimental Strategy/Machine Constraints and essential diagnostic**
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  - Train **two** separate NNs for high beta scenarios in **TCV** and in **AUG**
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  - **Extrapolate** results for **JT-60SA** high beta scenario

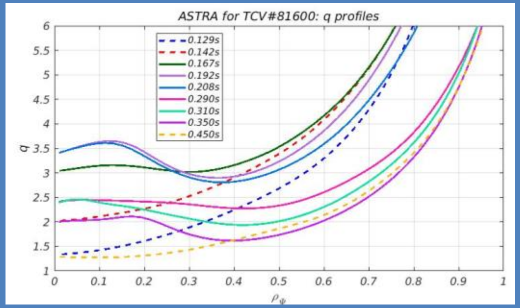
P203: Density versus Temperature ITBs in TCV

- **Proponents and contact person:**
- Sergei.Sharapov@ukaea.uk

- **Scientific Background & Objectives**
  - During previous RT09 experiments on TCV on “Physics understanding of energetics particles confinement and their interplay with thermal plasma” a number of transient ITBs was observed. Some of these ITBs were in plasma density, but not in temperature (similar to, e.g. C-MOD), and other – in temperature, but not in density (like on JET). Technically, the switch on TCV was simple. However, we still don’t understand how this switch works as not all diagnostics were available and more data is needed.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Type of plasma scenario or parameter explored to answer the main questions: Reference pulse #81511
  - Scan in vertical position of plasma with dominant NBI heating
  - Thomson scattering, CXRS, MSE, and NPA are essential diagnostic

Evolution of q-profile in these reversed-shear TCV plasmas



Proposed pulses

Device	# Pulses/Session	# Development
AUG		
MAST-U		
TCV	20/2	10/1
WEST		

P203: Density versus Temperature ITBs in TCV

- **Proponents and contact person:**
- Sergei.Sharapov@ukaea.uk

Priority: P1-TCV, Possibly merged with 190

- **Scientific Background & Objectives**
  - During previous RT09 experiments on TCV on “Physics understanding of energetics particles confinement and their interplay with thermal plasma” a number of transient ITBs was observed. Some of these ITBs were in plasma density, but not in temperature (similar to, e.g. C-MOD), and other – in temperature, but not in density (like on JET). Technically, the switch on TCV was simple. However, we still don’t understand how this switch works as not all diagnostics were available and more data is needed.
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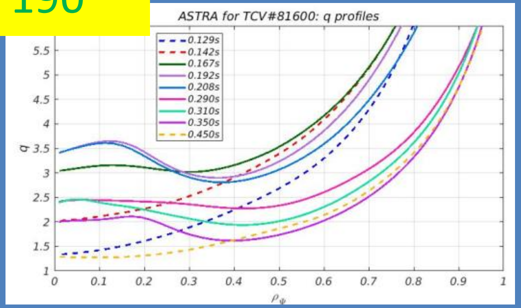

Proposed pulses

Device	# Pulses/Session	# Development
AUG		
MAST-U		
TCV	20/2	10/1
WEST		