18th November 2024

RT08: Physics and operational basis for high beta long pulse scenarios
Discussion about proposals and allocated priorities

M. Baruzzo

On behalf of WPTE TFLs

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Research Topic Coordinators

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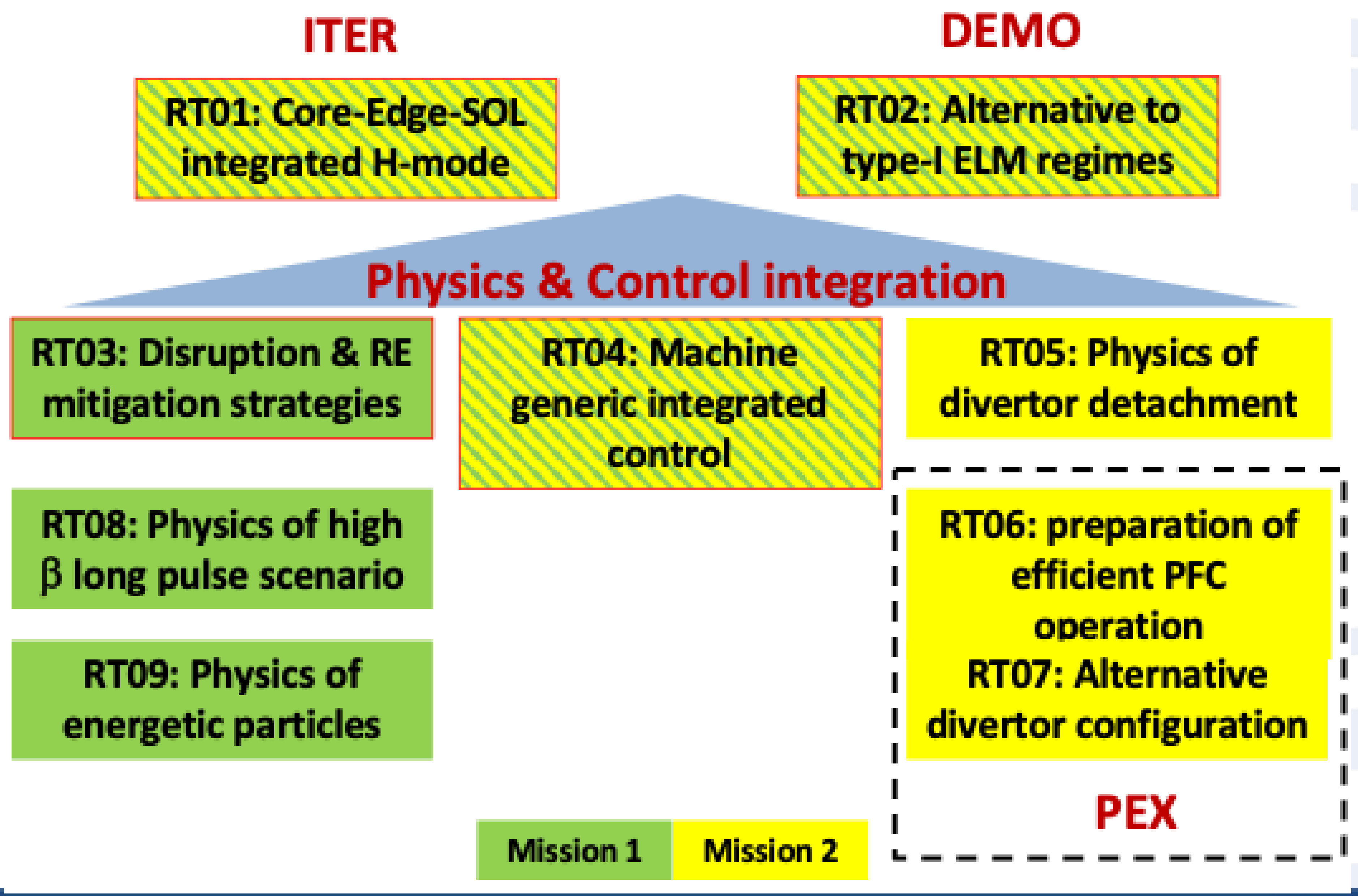
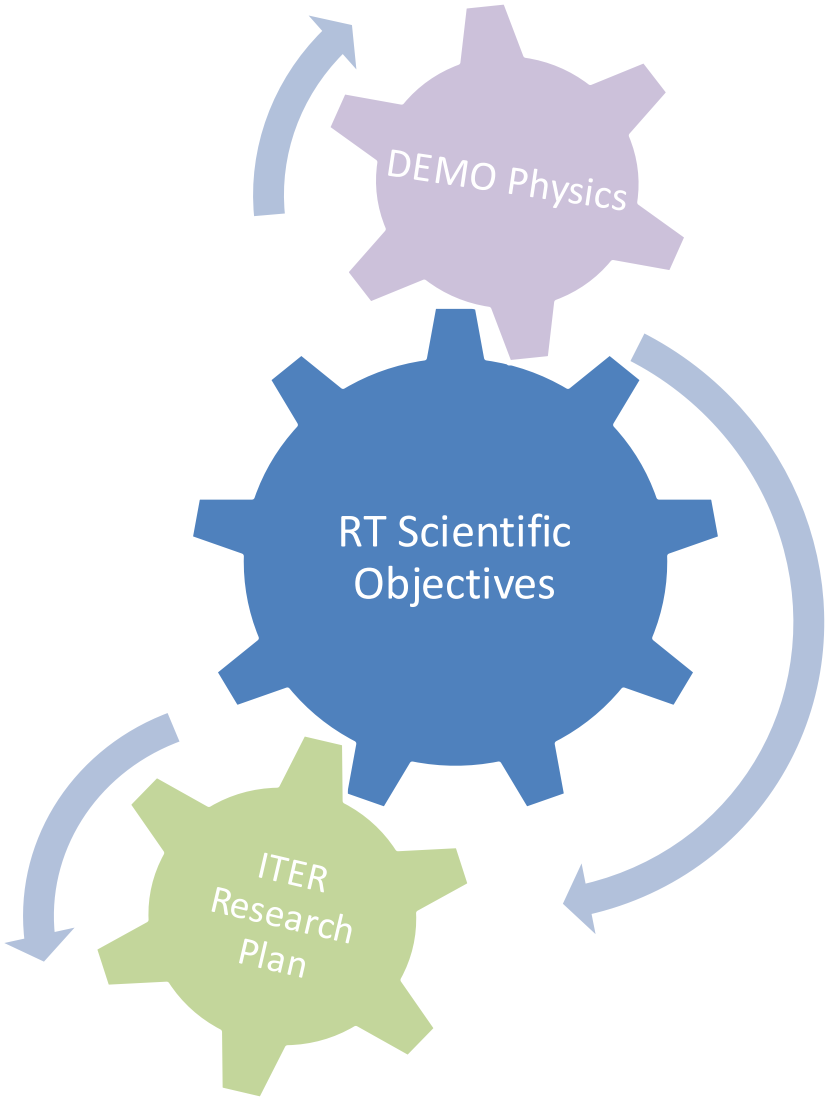
Introduction



Prioritization scheme and criteria



Proposal Evaluated according to the criteria:

Adherence to the Scientific Objectives

Team effort

Size and feasibility

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

P1: experimental priority for 2025: machine time granted but pulse budget might need reduction

P2: will be done if time allows after Prio 1 experiments are completed

P3: back-up programme

PB: piggy-back experiment/pure analysis proposal

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 devices in view of subsequently testing the scenario in JT-60SA W-wall and extrapolating to ITER and DEMO
D3	Characterize the fast and thermal ion transport together with the ExB, magnetic shear, turbulence conditions in steady-state scenarios at high-q
D4	Develop projection schemes of long pulse at high βN as a potential reactor scenario
D5	Develop an intrinsically steady-state solutions at high βN (>3) in terms of q/pressure profile with mild MHD activity (qmin ³ 1), and compare it to the expected JT-60SA and DEMO scenarios particularly in terms of extending operational space toward high Gwfractions
D6	Develop steady-state scenarios in metallic devices at high βN in conditions of MHD characteristics close or above the no-wall ideal limit and assess feasibility on JT-60SA in view of DEMO

2025	AUG	TCV	MAST-U	WEST
Tentative allocation	50	200	48	15
Total proposed	242	196	239	75
Scientific/dev.	120/122	116/80	159/80	55/20

Summary of proposals (32)

No	RT	Proposal name	Proposer
171	RT04	Flux pumping studies on MAST-U	Sam Blackmore et al.
172	RT04	Investigation of 1,1 Flux Pumping (FP) Parameter Dependence	Alexander Bock et al.
173	RT04	Compatibility of Flux Pumping with Exhaust Solutions in AUG	Alexander Bock et al.
174	RT04	Towards steady-state profiles from start to end of flat top	Olivier Sauter , Cassandre Contré et al.
175	RT04	ECCD Efficiency, Flux Pumping vs Shaped and Elevated q	Andreas Burckhart et al.
176	RT04	Reproducing and Quantifying 3/2 Flux Pumping at AUG	Andreas Burckhart et al.
177	RT04	Hybrid scenario at high βN with mild MHD activity on MAST-U	Gianluca Pucella , Francesco P Orsitto et al.
178	RT04	Long pulse operation in radiative divertor regime	Remi Dumont et al.
179	RT04	Current evolution in the plasma ramp-up: an inter-machine comparison with MHD markers	Fulvio Aureimma, Gianluca Pucella et al.
180	RT04	Investigation of Stability in qmin>1 Scenarios on AUG	Jörg Stober et al.
181	RT04	What is the Local Impact of q and s on Core Transport?	Jörg Stober et al.
182	RT04	Delayed H-mode entry to improve core performance	Christopher Ham
183	RT04	High density, high poloidal beta	Christopher Ham
184	RT04	Development and optimization of high-bootstrap, high-beta tokamak scenarios towards steady state	Chiara Piron, Stefano Coda et al.

← coming from RT09

Summary of proposals

Flux pumping, Steady state scenario, Hybrid AT front end studies, ITB transport

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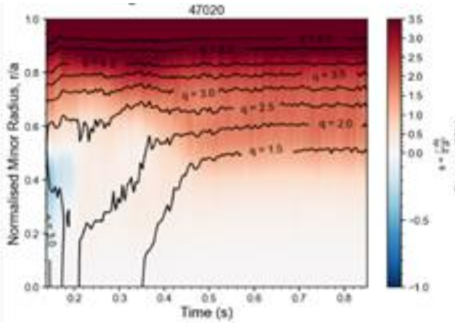
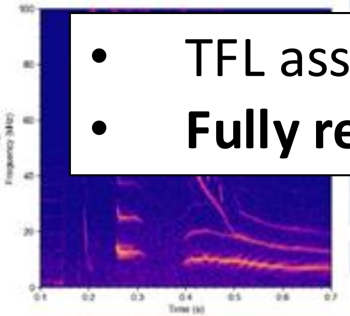
184	RT04	Development and optimization of high-bootstrap, high-beta tokamak scenarios towards steady state	Chiara Piron, Stefano Coda et al.

171: Flux pumping studies on MAST-U

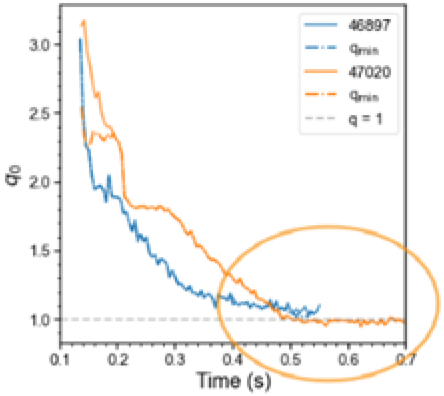
- **Proponents and contact person:**
  Sam.blackmore@ukaea.uk
- **Scientific Background & Objectives**
  Determine impact of fuelling rate and toroidal field strength on access to flux pumping regime.
  Explore flux pumping mechanism at elevated q0
  Acquire database of systematic scans for cross machine comparison of flux pumping on MAST-U vs AUG / JET / TCV.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Use current overshoot scenario developed in WPTE-08 during 2024 experimental campaign.
  - Perform scan in fuelling rate to assess impact on flux pumping.
  - Perform toroidal field scan (90kA-120kA) to modify q evolution to understand impact on flux pumping.
  - Requires MSE constrained EFIT, TRANSP analysis.
  - Essential diagnostics: MSE, TS, Magnetics

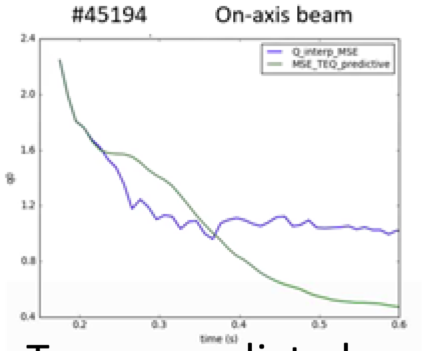




- TFL assessment: P1
- **Fully relevant**



Proposed pulses



Transp predicted q profile vs MSE EFIT q profile

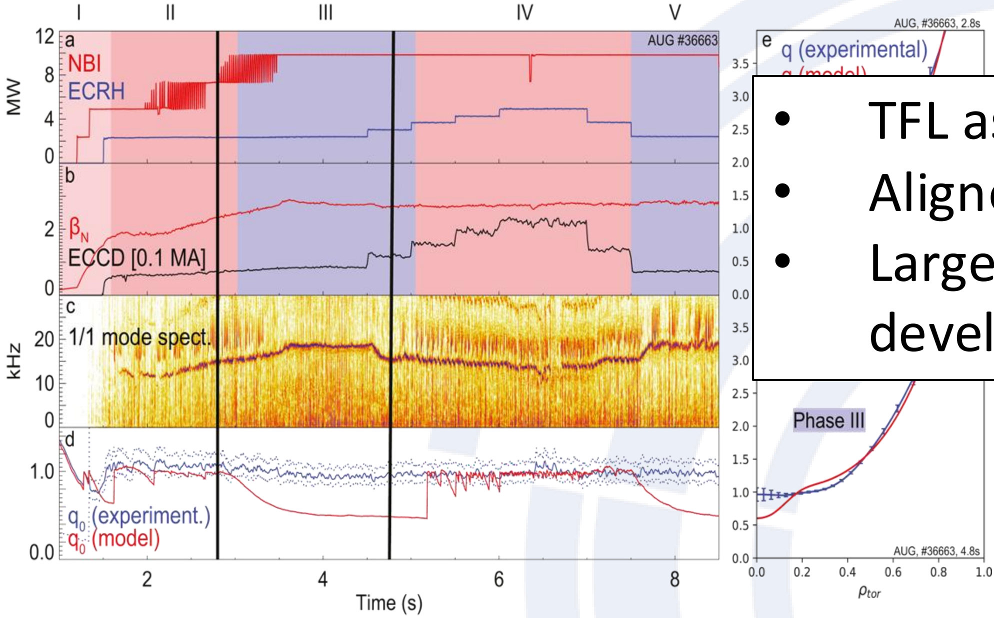
Device	# Pulses/Session	# Development
JET		
MAST-U	18/3	
TCV		
WEST		

172: 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/MAST-U FP scenarios and, as far as possible, dimensionless parameter-matched reproductions of recent FP JET pulses. This would encompass q_{95} scans to discriminate β_{N} and β_{pol}, but also variations of δ and *r/R* (inter-machine). 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.



- TFL assessment: P1
- Aligned with D1
- Large number of development pulses

Proposed pulses

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

Machine req AUG: 15MW NBI, 5MW ECRH, (I)MSE
Machine req MAST-U: 4MW NBI, max available EBW, MSE

173: Compatibility of Flux Pumping w/ Exhaust Solutions in AUG

- **Proponents and contact person:**

Alexander Bock alexander.bock@ipp.mpg.de
A Burckhart, M Bernert, T Pütterich,
J Stober, W Suttrop

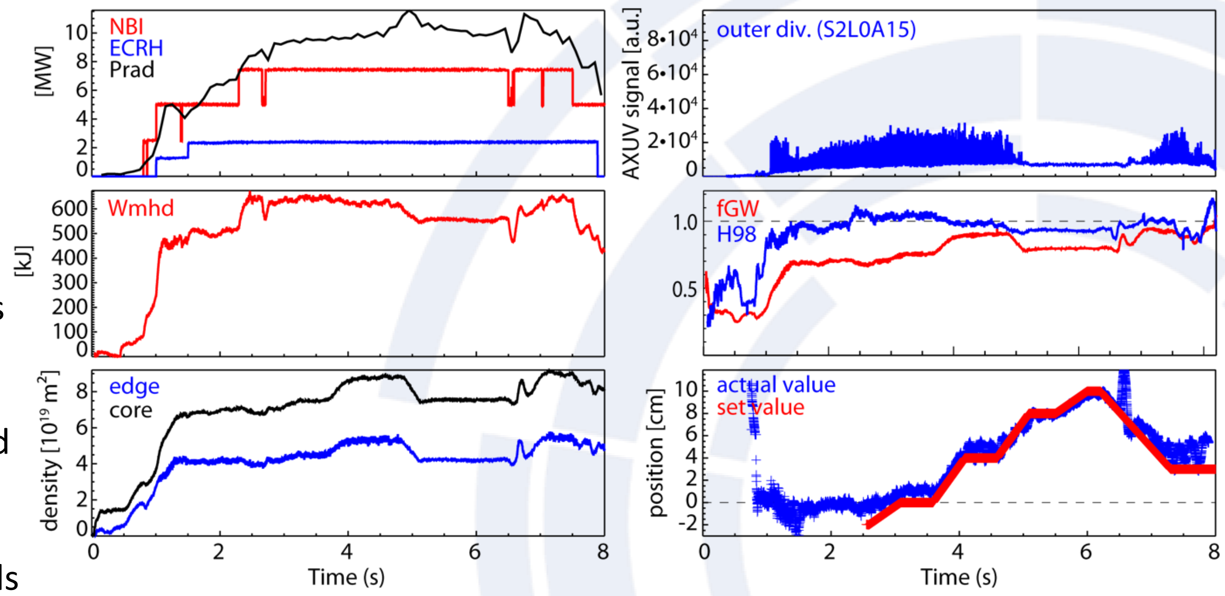
- **Scientific Background & Objectives**

  Integration of AT or Hybrid scenarios with exhaust solutions remains challenging in present devices
  due to the sometimes contradictory requirements
  for the core and edge conditions. Flux Pumping as a variant of hybrid scenarios has the potential to bridge the gap in present devices the ability to be studied even without high core CD capability.
  → Scenario development from established AUG FP scenarios towards XPR conditions and/or ELM suppression via RMP coils.

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

  XPR can in principle exist in plasmas of any shape and q_{95} → starting from an established AUG FP pulse, increase fueling towards XPR conditions while monitoring FP presence.
  ELM suppr. much less flexible but requires low density as well → starting from AUG FP develop plasma towards ELM suppr. conditions

AUG # 36655 (I_p=800kA, B_T=2.5T ; XPR but FP-like)



Proposed pulses

Device	# Pulses/Session	# Development
AUG	10	>50
MAST-U		
TCV		
WEST		

- TFL assessment: P1
- Aligned with D2
- Large number of development pulses

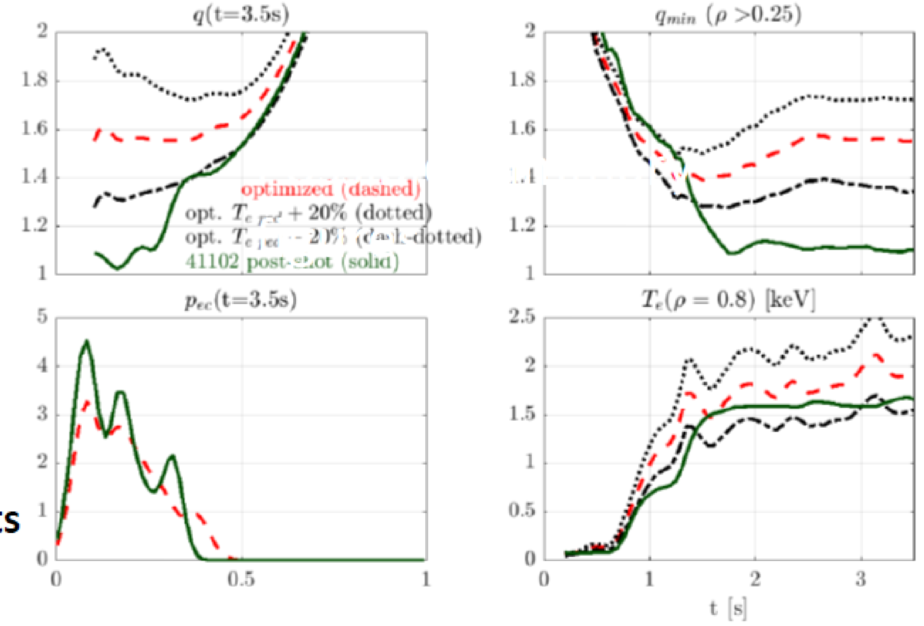
Machine req: 15MW NBI, 5MW ECRH, (I)MSE

174: Towards steady-state profiles during full flat top

- **Proponents and contact person:**
olivier.sauter@epfl.ch,
Cassandre.Contre@epfl.ch

- **Scientific Background & Objectives**
  Aim at stable advanced scenario, low/0 inductive current, from start of flat top
  Integrated advanced scenario from ramp-up to ramp-down

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  Continue from successful developments in previous year. Use RAPTOR to optimize ramp-up, flat-top and ramp-down in order to obtain a steady-state scenario from start of flat top, while avoiding performance limiting modes. [S. Van Mulders et al, Nucl. Fusion 64 (2024) 026021, PhD thesis]. Add RT-control from pedestal measurements informed by simulation
  Validation of procedure important for ITER and other devices to accelerate developments: optimization, cost functions, relevant constraints, experimental validation



Proposed pulses

Device	# Pulses/Session	# Development
AUG	10	5
MAST-U		
TCV		
WEST		

- TFL assessment: P2
- Probably relevant to RT04

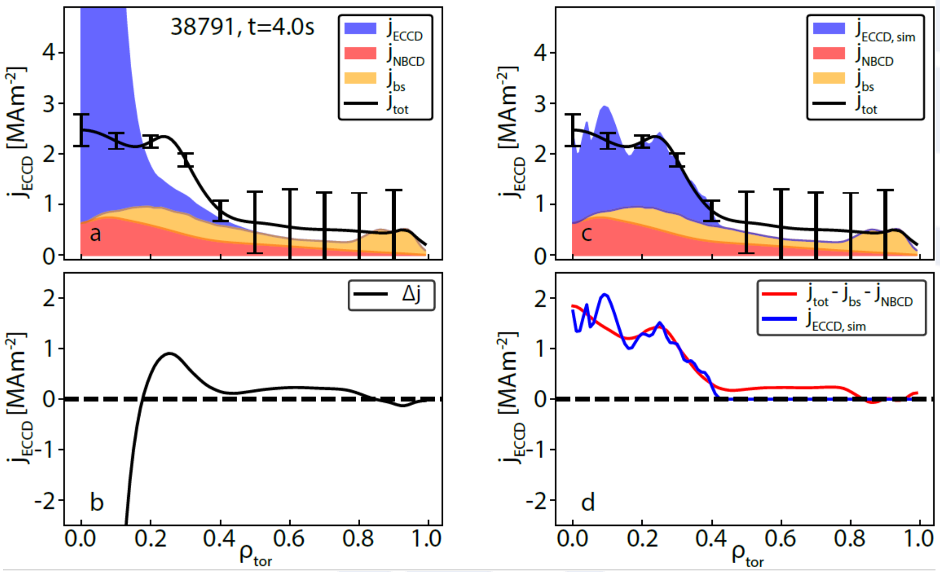
175: ECCD efficiency, flux pumping vs shaped and elevated q

- **Proponents and contact person:**

A Burckhart Andreas.Burckhart@ipp.mpg.de
A Bock, T Pütterich, J Stober, R Schramm,
R Fischer, M Reich

- **Scientific Background & Objectives**

  This proposal aims to experimentally confirm the superior efficiency of the flux pumping (FP) mechanism for current drive compared to off-axis ECCD. Previous attempts were inconclusive due to challenges in achieving stable conditions with off-axis ECCD. This study involves direct comparisons of flux consumption and stability between flux pumping and off-axis ECCD scenarios.



[A. Burckhart, submitted to N.F.]

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Scenario development already mature but further optimization necessary
  - Strategy involves optimizing ECRH angles and timings to match the flux-pumping q-profile.
  - Compare OH flux consumption, analyze with IDE + IMSE, and compare loop voltage profiles.
  - Confirm total driven current with ECCD codes and validate current redistribution in FP simulations.
  - Machine: IMSE, MSE, 15MW NBI, 5MW ECRH

Proposed pulses

Device	# Pulses/Session	# Development
AUG	6	14
MAST-U		
TCV		
WEST		

- TFL assessment: P1
- Aligned with D1

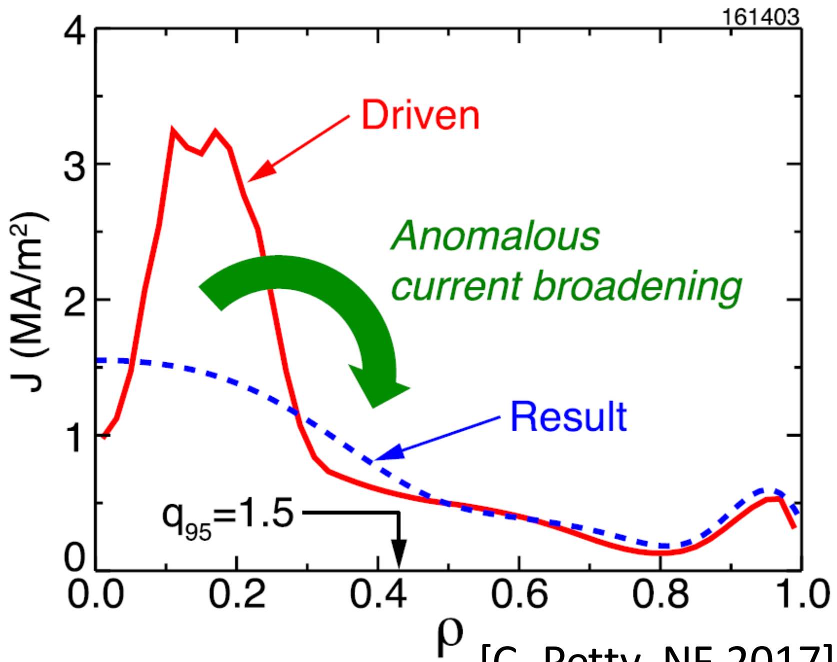
176: Reproducing and quantifying 3/2 flux pumping at AUG

- **Proponents and contact person:**

A Burckhart Andreas.Burckhart@ipp.mpg.de
A Bock, T Pütterich, J Stober, R Schramm,
R Fischer, M Reich

- **Scientific Background & Objectives**

  The aim of this proposal is to reproduce the 3/2 flux pumping results at ASDEX Upgrade, which has a full-W wall and much weaker wall stabilization than DIII-D. The comparison of the results between the 2 otherwise similar machines might give insight into the applicability of 3/2 flux pumping in a reactor.



[C. Petty, NF 2017]

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Develop the 3/2 scenario at AUG
  - Test the flux pumping boundaries (ECCD and beta)
  - Compare the maximal sustainable beta with DIII-D and with 1/1 flux pumping, then suppress 3/2 NTM to observe reappearance of 1/1 activity
  - Machine: IMSE, MSE, 15MW NBI, 5MW ECRH

Proposed pulses

Device	# Pulses/Session	# Development
AUG	10	23
MAST-U	0	
TCV	0	
WEST	0	

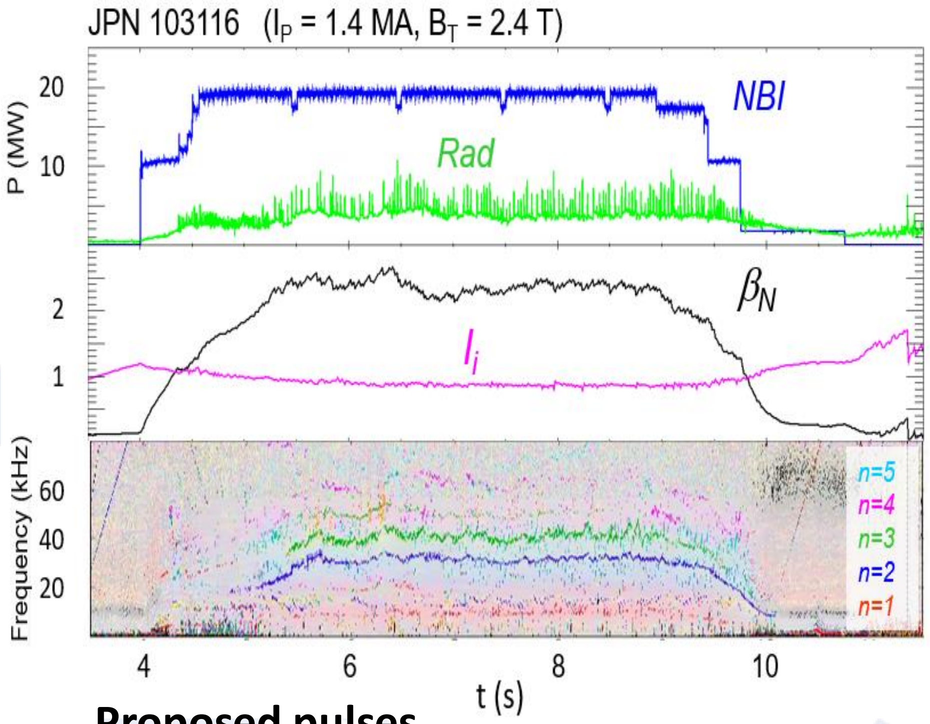
- TFL assessment: P2
- Aligned with D1
- Interesting in view of operation with qmin>1

177: Hybrid scenario at high βN with mild MHD activity on MAST-U

- **Proponents and contact person**
  - Gianluca Pucella (gianluca.pucella@enea.it)
  - Francesco Paolo Orsitto, Luca Garzotti, Fulvio Auriemma
    Edmondo Giovannozzi, Daniele Brunetti, …

- **Scientific Background & Objectives**
  - Recent high βN experiments on JET allowed to identify optimal sets of parameters for pulses with mild MHD activity and inform the design of future JT-60SA pulses
  - Ip waveform (slope and overshoot) leading to a flat q-profile in the core region
  - Correlation between the NBI power/timing and the detection of MHD activity (n=2,3 NTM) in hybrid pulses with q0 > 1.1
  - Evaluation of the effect of high-beta NTM on the confinement properties and determination of the optimal parameters for pulses with mild MHD activity
  - Investigation of the dependence of the maximum βN achievable on BT (q95)

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Optimizing the q-profile shape through current waveform and electron density scans
  - Performing NBI scans (start time and power), affecting q0 and βN
  - Pulses at Ip < 0.75 MA with current overshoot and NBI injection before the q=1 arrival
  - MSE as essential diagnostic



Proposed pulses

Device	# Pulses/Session	# Development
MAST-U	16 / 2	16 / 2

- TFL assessment: P2
- Aligned with D5/D6
- Different confinement properties with ST makes JT-60SA extrapolation uncertain

179: Current evolution in the plasma ramp-up: an inter-machine comparison with MHD markers

- **Proponents and contact person:**
  fulvio.auriemma@igi.cnr.it, gianluca.pucella@enea.it

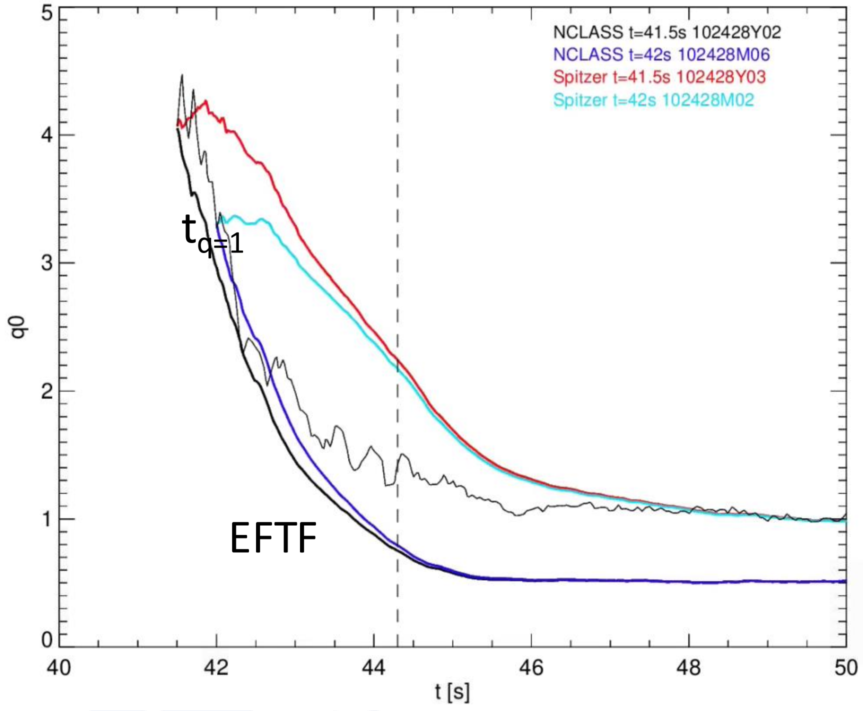
- **Scientific Background & Objectives**
  Hybrid-like plasma q profile can depend on the current profile evolution during the ohmic ramp-up phase. We propose an intermachine study to develop an effective strategy for predict the early phase q evolution, extending the present analysis ongoing on JET:
  - Compute the q profile with different resistivity models and plasma parameters to match the experimental evolution exploiting MHD marker q=1 arrival time ($t_{q=1}$) and q=1 radial position
  - Quantify the accuracy of the q profile reconstruction during times when diagnostics data (e.g. MSE, polarimetry) are unavailable via sensitivity scan on plasma paramter (Z_{eff}, n_e, T_e, etc.)
- **Experimental Strategy/Machine Constraints and essential diagnostic**

From reference pulses (AUG: 40832, MAST-U:47036):

- Toroidal field scan at fixed current (4 values)
- Plasma current scan at fixed magnetic field (4 values)
- Current waveform shape: rising time, overshoot (4 values)
- Cross scans are also desirable to disentangle correlations

Required: polarimetry constrained EFIT at early time, impurity and radiation profile
TRANSP/ASTRA analysis of q evolution, comparison with MHD markers

JET



Proposed pulses

Device	# Pulses/Session	# Development
AUG	24	
MAST-U	24	4

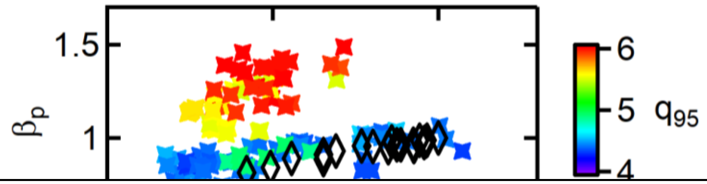
- TFL assessment: P1.5
- Polarimetry and MSE data AUG not fully available at the moment

178: Long pulse operation in radiative divertor regin

- **Proponents and contact person:**
  - R. Dumont (remi.dumont@cea.fr), P. Maget , P. Manas, A. Ekedahl, N. Fedorczak, T. Fonghetti, D. D. Moiraf, J. Morales, Ph. Moreau, R. Nouailletas, C. Reux, Y. Savoye-Peysson

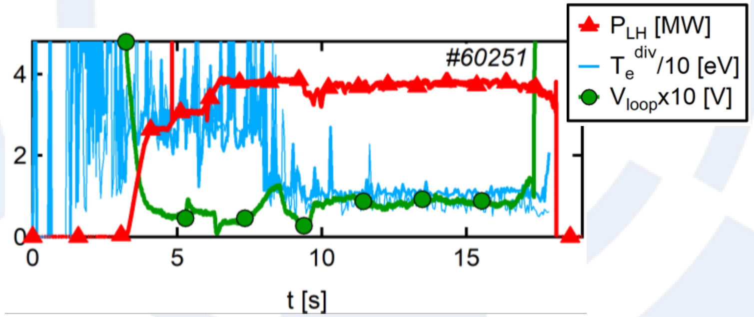
- **Scientific Background & Objectives**
  - **Background**
    - Radiative divertor regime is required to prevent UFO events on long plasma duration
    - Demonstrating a fully controlled radiative divertor regime on long duration is challenging
    - Achieving high performance (high β) in XPR/low loop voltage pulses requires optimization
    - Development work in detached regime has just started within RT08
    - Challenges to address:
      - N2 injection rate optimization
      - XPR transition identification at low plasma current
      - LHCD efficiency optimization (could be compensated by improvement of confinement)
  - **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
      - Qualify confinement, W sources and contamination
    - Maximize performance of detached steady-state pulse
      - Continue ramp-up/current profile optimizations
      - Apply ECRH/CD to enlarge parameter space
      - Test Ne injection (better exhaust than N) if time allows

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - Reference pulse : WEST pulse 60227, at reduced current (250kA)
    - LSN plasma with LHCD **+ ECRH**, N2 seeding
  - Evaluate toll on Vloop caused by various levels of N2 injection in feed-forward
    - several plateaus in development pulses, checking XPR transitions using Langmuir probes
  - Once adequate N2 level determined, go to feedback control on edge interf. measurement
  - Scans in plasma current, electron density, …
  - Essential diagnostics: SXR, HXR, XICS, DSURVIE, DVIS, **Langmuir probes**



- TFL assessment: P1
- Aligned with D2
- Depends on successful implementation of ECRH for high Beta

β_p and V_{loop} vs Zeff in various XPR pulses



XPR regime in a Vloop~100mV pulse

Proposed pulses

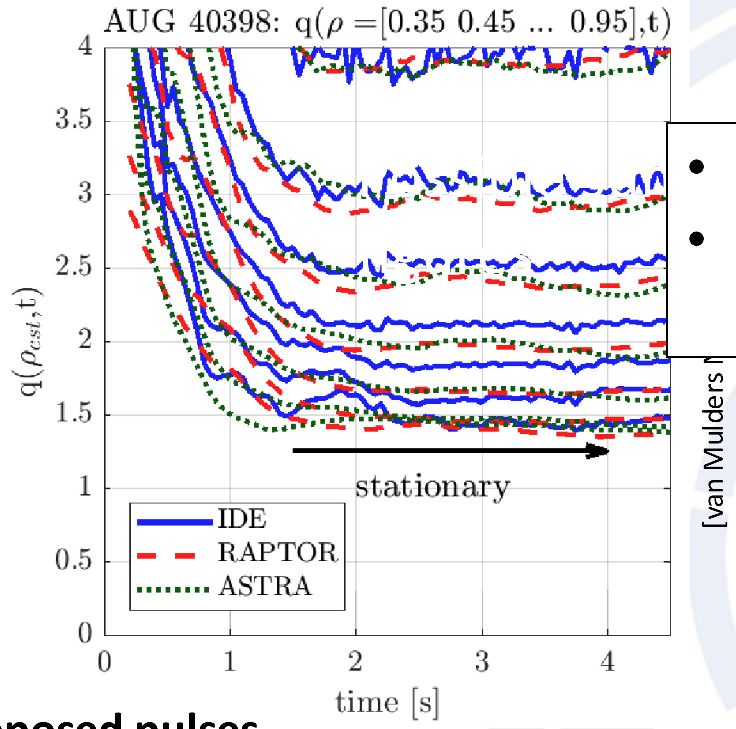
Device	# Pulses/Session	# Development
WEST	40/2	20

180: Investigating stability in q_{min}>1 scenarios on AUG

- **Proponents and contact person:**
  Jörg Stober joerg.stober@ipp.mpg.de
  A Burckhart, M Reich, R Fischer, A Bock

- **Scientific Background & Objectives**
  Characterising stability limits in AUG q_{95}=4 ctr-ECCD high-qmin (q_{min} ~ 1.5) discharges. These were already performed in the 2022 campaign but suffered from unclear IMSE data, i.e. straightforward to execute

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  Reproduce AUG #40398 and related discharges if and when sufficiently high-quality IMSE data is available such that even small features in q can be believed. Model results with MHD codes such as CASTOR3D and formulate ways to improve stability; test these again in the experiment.
  Machine req: valid IMSE, 15MW NBI, 5MW ECRH



- TFL assessment: P2
- Continuation of AUG internal campaign

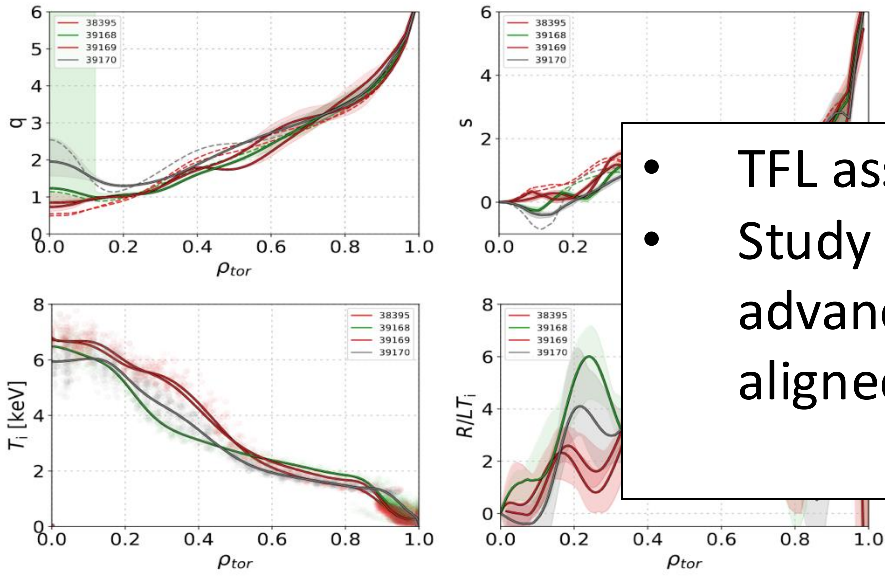
Proposed pulses

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

181: What is the local impact of q and s on core transport?

- **Proponents and contact person:**
  Jörg Stober joerg.stober@ipp.mpg.de
  M Reisner, R Fischer, E Fable, A di Siena
- **Scientific Background & Objectives**
  Recent experiments with varied *q* profiles on AUG cast doubts on some effects expected from reversed shear or flat *q* established in literature. However, the IMSE data in these experiments might be incorrectly interpreted. These doubts should be verified or dispelled by repeating the experiments when good IMSE calibration is available again, which is expected for the coming AUG campaign.
- **Experimental Strategy/Machine Constraints and essential diagnostic**
  Repeating experiments from M Reisner's PhD thesis [1] with valid IMSE data and analysis the results using state of the art transport codes such as TGLF and GENE
  Machine req: valid IMSE, 15MW NBI, 5MW ECRH

  [1] https://edoc.ub.uni-muenchen.de/30913/1/Reisner_Maximilian.pdf



- TFL assessment: P1
- Study of transport in advanced scenario, aligned with D3

Figure 5.7: Ensemble of profiles comparing the effects of applying ECCD with different settings in several different AUG discharges. T_i and R/L_{T_i} are fitted with IDI, q and s are reconstructed with IDE, taking IMSE data into account. The IMSE offset is based on discharge #38571, with the profiles using the offset based on #39587 being added with dashed lines for comparison.

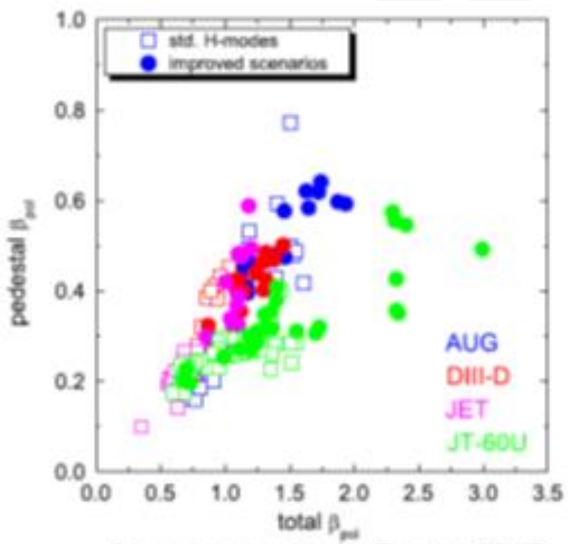
Proposed pulses

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

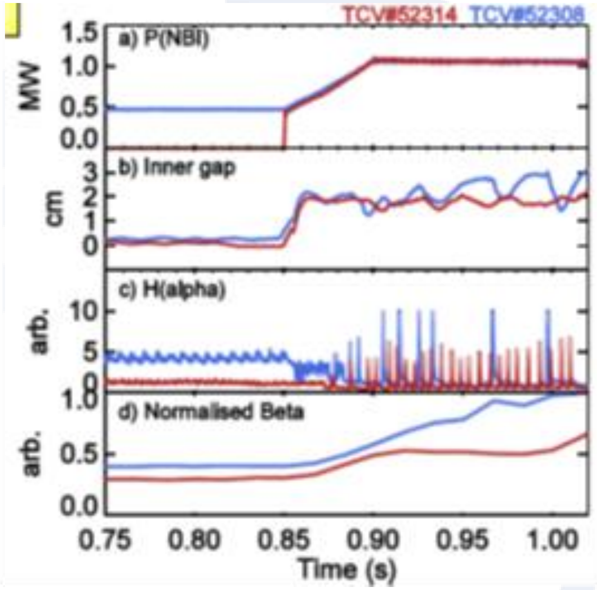
182: Delayed H-mode entry to improve core performance

- **Proponents and contact person:**
- Christopher.ham@ukaea.uk, Samuli Saarelma, San Blackmore, Stefano Coda, …

- **Scientific Background & Objectives**
  - Increase plasma performance (high βN) on MAST-U, AUG, TCV and WEST by delaying H-mode entry. This should lead to higher pedestal and core beta.



Maggi et al, *Nucl. Fusion* 2007



- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - We will start machines in configuration unfavourable to H-mode and heat then move to trigger H
  - This should produce higher pedestal p core pressure
  - Previous work showed positive results

- TFL assessment: P1.5?
- Increase plasma performance entering H-mode at higher core pressure

Proposed pulses

Device	# Pulses/Session	# Development
AUG	#15 shots	
MAST-U	#20 shots	
TCV	#20 shots	
WEST	#15 shots	

183: High density, high poloidal beta scenari

- **Proponents and contact person:**
- Christopher.ham@ukaea.uk, Sam Blackmore, Stefano Coda, Chiara Piron, …

- **Scientific Background & Objectives**
  - Increase plasma performance (high βp) on MAST-U and TCV and show that very high Greenwald fraction is possible. Recent DIII-D experiments have shown high βp exists with high density. This is very power plant relevant.
  - MAST-U operation above q=2 will remove 2/1 tearing mode.

- **Experimental Strategy/Machine Constraints and essential diagnostic**
  - MAST-U: Careful ramp up to avoid IREs. Find optimal current to get the best from the NBI while keeping q high. High triangularity may well be beneficial.
  - TCV: Explore scenario with off axis heating using NBI and X3 (~5MW)

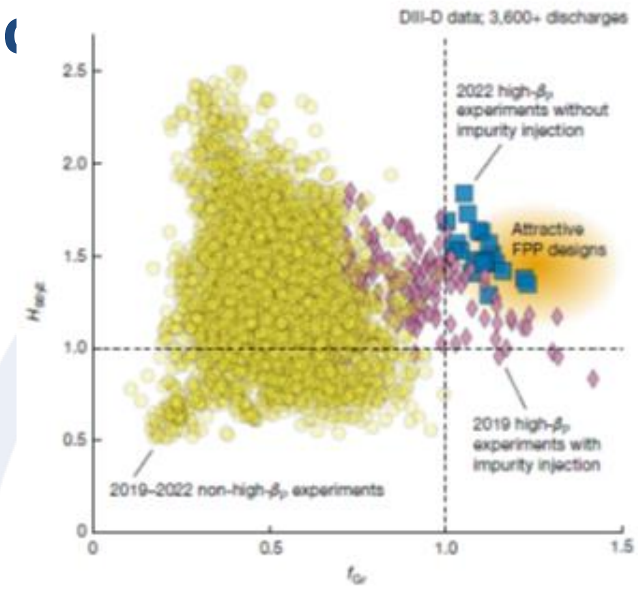


Fig. 1 | Database of H_{98y2} and f_{Gr} for DIII-D discharges. More than 3,600 discharges are included. Violet diamonds show high-β_p experiments performed in 2019 with impurity injection. Blue squares are the new high-β_p experiments performed in 2022 without impurity injection. Yellow circles represent 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.

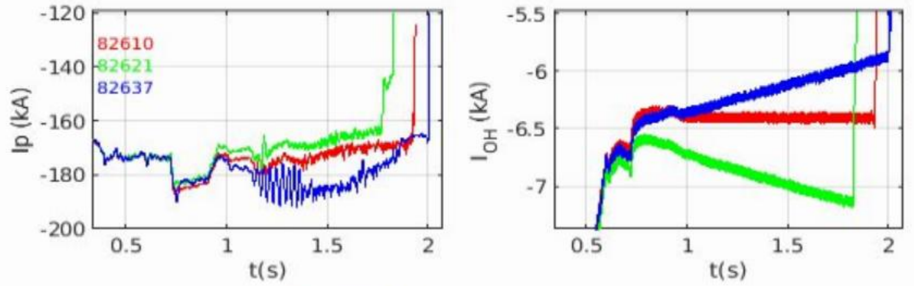
Ding, S., Garofalo, A.M., Wang, H.Q. *et al.* A high-density and high-confinement tokamak plasma regime for fusion energy. *Nature* **629**, 555–560 (2024).

- TFL assessment: P1
- High Betap high density scenario with large ITB. AUG?

elopment		
MAST-U	#16 shots	
TCV	#16 shots	
WEST	#0 shots	

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

OHMIC PERTURBATIONS ON A TCV STEADY-STATE FULLY NON-INDUCTIVE SCENARIO WITH DTBs



- **Proponents and contact person:**

C. Piron, S. Coda, O. Fevrier, H. Reimerdes, I. Voitsekhovitch

- **Scientific Background & Objectives**

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

- TCV:
  - Core-edge integration in steady-state fully non-inductive high-beta scenarios (RT08+RT05)
  - He transport and H-mode access studies in RS configuration (relevant to He particle transport and He ash removal in reactor's AS)
- MAST-U:
  - Operational recipes to maximise betaN and fNI in a stable and stationary manner

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

- TCV: (essential diagnostics: TS, MAG, CXRS, cECE, TPCI, FIDA, SPR, THB, MANTIS)
  - Exploit the additional EC gyrotron (dual-frequency X2-X3) for MHD control, current profile tailoring and/or core heating.
  - Test detachment/divertor cooling techniques (N2 seeding), study exhaust and impurity transport
  - Investigate He transport and the H-mode access in the RS configuration with different H-D and He-D concentration, using the available gas valves to inject He or H when the RS is produced
- MAST-U: (essential diagnostics: TS, MAG, MSE, BES, DBS, FIDA, FILD)
  - Ip, k scans and optimization of NBI recipes (both power ratio and injection time)

- TFL assessment: P1
- Backbone proposal for AT scenario development in TCV and MAST-U, with focus on core-edge integration

Proposed pulses

Device	# Pulses/Session	# Development
AUG		
MAST-U	40	30
TCV	80	80
WEST		

Summary of proposals

Flux pumping, Steady state scenario, Hybrid AT front end studies, ITB transport

No	RT	Proposal name	Proposed Pulses AUG/TCV/MAST-U /WEST	Priority
171	RT04	Flux pumping studies on MAST-U	0/0/21/0	P1
172	RT04	Investigation of 1,1 Flux Pumping (FP) Parameter Dependence	55/0/55/0	P1
173	RT04	Compatibility of Flux Pumping with Exhaust Solutions in AUG	60/0/0/0	P1
174	RT04	Towards steady-state profiles from start to end of flat top	15/0/0/0	P2
175	RT04	ECCD Efficiency, Flux Pumping vs Shaped and Elevated q	20/0/0/0	P1
176	RT04	Reproducing and Quantifying 3/2 Flux Pumping at AUG	33/0/0/0	P2
177	RT04	Hybrid scenario at high βN with mild MHD activity on MAST-U	0/0/32/0	P2
178	RT04	Long pulse operation in radiative divertor regime	0/0/0/60	P1
179	RT04	Current evolution in the plasma ramp-up: an inter-machine comparison with MHD markers	24/0/30/0	P1.5
180	RT04	Investigation of Stability in qmin>1 Scenarios on AUG	10/0/0/0	P2
181	RT04	What is the Local Impact of q and s on Core Transport?	10/0/0/0	P1
182	RT04	Delayed H-mode entry to improve core performance	15/20/20/15	P1.5
183	RT04	High density, high poloidal beta	0/16/16/0	P1
184	RT04	Development and optimization of high-bootstrap, high-beta tokamak scenarios towards steady state	0/160/70/0	P1