List of 2015-2016 MST1 Coordinating Tasks, MST1 Scientific Tasks, MST1-AUG expriments, MST1-TCV experiments

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I. MST1 Coordinating Tasks

I.1. List of Coordinating Tasks

The coordinating tasks aim at coordinating modelling activities throughout the different experiments on AUG and TCV. For these tasks, **only task coordinators are required .** The task coordinators are expected to:

- Ensure adequate flow of information between the modellers and with the TFLs
- Act as contact persons for modelling specific questions in their area.
- Liaise with the scientific coordinators to identify modelling needs and capabilities.
- Ensure interaction with other coordination areas; e.g. combined modelling of SOL, pedestal and core (e.g. how do SOL conditions affect pedestal and how does the pedestal affect the core and vice versa)
- Organise small workshops to discuss the modelling progress and results.
- Encourage the use of the ITER Physiscs department Work package Code Development and of the ITER Integrated Modelling Analysis suite (IMAS) modelling tools.
- Interact with their JET counterpart (note that for WP JET1 this responsibility is fulfilled by JET task force leaders/deputy leaders)

Coordinating Task Id	Coordinating Task Title	Coordinating Task Deliverables	Related JET Tasks
MST1-CT15-1	Coordination of core transport modelling	1. Arrange strong interaction within MST1 teams on the application of gyrokinetic modelling and comparison to experimental data 2. Coordinate the application of the ETS code for comparison with experimental data. 3. Initiate discussion with JET on core transport activities	These tasks have their JET counterpart and a strong collaborative spirit is expected
MST1-CT15-2	Coordination of modelling of ELMs and pedestal	1. Coordinate pedestal stability studies and needs across the experiments 2. Specifically, ensure that JOREK modelling of ELM dynamics and target power loads is performed within the appropriate experiments and in conjunction with ER proposal WP15-ENR-01-IPP-05 3. Support benchmarking of EPED like modelling in collaboration with ER proposal WP15-ENR-01-CCFE-03.	
MST1-CT15-3	Coordination of edge and SOL modelling	1. Coordinate the scarce resources for edge modelling for the experiments 2. Ensure interaction with the ELM/Pedestal modelling task on integrated modelling in the two areas 3. Monitor the collection of relevant data during the experiments to allow proper edge and SOL modelling with the available codes	
MST1-CT15-4	Coordination of modelling on MHD stability and its control	1. Coordinate modelling of MHD instabilities, including 3D MHD, and including interpretative modelling in support of data analysis and modelling of control 2. Monitor the collection of relevant data during the experiments to allow proper MHD modelling with the available codes. 3. Liaise with other MHD modelling activities in the EU.	
MST1-CT15-5	Coordination of fast ion modelling (stability and	1. Develop integrated modelling of fast ion instabilities and their effect on the fast ion distribution including changes to the equilibrium.	

	transport)	2. Compare the modelling to existing data on all MST1 devices (AUG, MAST and TCV). 3. If available in 2016 ensure benchmarking of IMAS/WPCD workflow on integrated fast-ion modelling.	
MST1-CT15-6	Coordination of filamentary transport modelling	1. Coordinate modelling of filament dynamics and related transport in slab geometry, in flux-tube simulations and within full SOL turbulence simulation environments. 2. Develop metrics for data-modelling comparison and perform such comparisons.	

I.2. How to apply to be task coordinator of an Coordinating Task

- **Apply through"Annex 5 - Form to propose participation in the MST1 programme"**
- **Note there are two worksheets in this file: "AUG proposed participation" for participation in MST1-AUG experimental campaign and "TCV proposed participation" for participation in MST1-TCV experimental campaign.**
- From the drop-down menu of column J, select the coordinating task you are interested in. Fill **both** the worksheet "AUG proposed participation" and worksheet "TCV proposed participation"

II. MST1 Scientific Tasks

II.1. List of Scientific Tasks

The Scientific Tasks aim at preparing the future MST1-MAST programme and at maximising the interaction with JET on keys topics (disruption prediction). They require a task coordinator and team members.

Scientific Task Id	Scientific Task Title	Scientific Task Deliverables	Relation with 2014 & 2015 MST1 task / experiments	Related to JET Tasks
MST1-ST15-1	Study the effect of the X-point topology on the target heat and particle fluxes in preparation of operation with advanced divertor configuration	1. Investigate the effect of the strike point position in existing MAST data on the SOL heat and particle fluxes. Determine the effect on the heat flux profile (decay length, divertor spreading parameter, peak) and of the particle flux. Assess the upstream changes of the SOL properties as the divertor leg is moved to larger radial positions. 2. Continue the modelling started under MST1-T14-10 to extrapolate towards MAST-U and DEMO.	MST1 2014 task T14-10 and T14-8 TCV15-2.4-3	
MST1-ST15-2	Improve integrated plasma control in preparation of operation with advanced divertor configuration on MAST-U	1. Develop integrated control algorithms for future operation of MAST-U based on existing MST1 tokamaks (AUG, TCV, MAST) data. Benchmark results of control modelling with common control tools used on EUROFusion tokamaks (e.g. CREATE tools). 2. Assess the optimal sensor position for advanced magnetic divertor and shape control.	MST1 2014 task T14-6 TCV15-2.4-3	
MST1-ST15-3	Disruption prediction	1. High priority: development of predictive tools based on first principles and/or on physics data and non-dimensional quantities and demonstration of their portability on several devices for real-time application. 2. Develop real-time predictorsion methods optimised in term of model training, success rate, anticipation time. 3. Develop real-time differentiation among different types of disruptions.	MST1 2014 task T14-11	T15-3 Disruption prevention & avoidance schemes for JET

II.2. How to apply for participation in Scientific Tasks

- Apply though **“Annex 5 - Form to propose participation in the MST1 programme”**
- **Note there are two worksheets in this file: “AUG proposed participation” for participation in MST1-AUG experimental campaign and “TCV proposed participation” for participation in MST1-TCV experimental campaign.**

- From the drop-down list in columns O, P, Q and R, enter the competencies applying the most to you (see list of competencies in Annex 4)
- From the drop-down list in columns AA, AB, AC, AD and AE, indicate scientific tasks you would like to contribute to with these competencies.
- In column AK/AL describe the work you wish to perform for these tasks at the AUG/TCV site (if relevant) and back in your home institution.
- In columns AM to AV for 2015 and in columns BC to BL for 2016, propose stays at the AUG / TCV site (if relevant)
  - To avoid formatting issues the dates to be entered are provided through a drop-down menu.
  - ENTER 1st DAY ON-SITE and LAST DAY ON-SITE (note that the date drop down menu does not allow arriving /leaving during week-end or on bank holidays). The PMU will estimate the travelling time associated taking into account the EUROfusion mission rules.
  - Stay can start 2 weeks ahead and end two weeks after the campaigns.
- Missions to MAST should be requested separately by email (see Annex 7 for contacts)
- In column AX for 2015 and in column BN for 2016, proposed analysis time back in your home institution, entering WEEKS.
- <u>If you wish to be task coordinator: </u>from the drop-down menu in column J, select the relevant task(s)

III. MST1 experiments

III.1. List of MST1-AUG experiments

Note: experiments in Helium are not listed by Headline but separately at the end of the table

MST1-AUG experiment Id	MST1-AUG experiment title	Numbers of Shots	MST1-AUG deliverables	Related MST1 experiment	Based on proposals	Related JET experiment
Headline1.1: Increase the margin to achieve high fusion gain on ITER (M. Beurskens & H. Meyer)						
AUG15-1.1-1	ITER baseline confinement and development of alternative scenarios	30	1. (Re-) establish q=3 and q=3.6 IBL scenario at (low) and high delta 2. Expand the parameters space in terms of β_N and ν to study accessible stationary regimes 3. Explore heat load mitigation and access to small ELMs by high neutral gas (1/3 cryo) and seeding (N, Ne or Ar) 4. Test active ELM mitigation with pellets and RMP (try to lower the collisionality): study the pellet lag-time as function of N content if possible as function of $\beta_{N,}$ perform a differential phase scan with the RMP coils. 5. Study the effects of a changed heating mix (more wave heating versus beams, lower torque) 6. Study plasma termination in collaboration with JET <u>*Modelling/Analysis needs:*</u> • *TRANSP run* • *Pedestal stability analysis* • *EPED modelling and testing* • *ELM analysis* • *Core energy and impurity transport (most likely gyrokinitec)* • *Confinement and ELM size scaling* • *SOL modelling on role of neutrals on pedestal stability and confinement*	**Joint with: TCV15-1.1-1**	H1.1_MST_D_1 H1.1_MST_D_32 H1.2_MST_D_3	M15-08 Integrating the building blocks of the ITER scenario
AUG15-1.1-2	Seeding and fuelling; effect on energy confinement and power degradation	32	1. Investigate power degradation of confinement in fuelled and N seeded plasmas 2. Study Z-dependence and the impact of radiation location as well as the effect impurity 'sticking' to divertor target plates on outgassing (C, Ne, O, Ar, Kr) 3. Study low and high triangularity for comparison with JET <u>*Modelling/Analysis needs:*</u> • *Pedestal stability analysis* • *EPED modelling and testing* • *Impurity radiation analysis and modelling*	**Joint with: TCV15-1.1-2**	H1.1_MST_D_10, H1.1_MST_D_21, H2.1_MST_D_13	M15-22 Impact of seeding gases on recycling behaviour, radiation pattern, pedestal and detachment

			• *ELM analysis,* • *Core energy and impurity transport (most likely gyrokinitec),* • *Confinement and ELM size scaling*			
AUG15-1.1-3	JET identity experiment in improved H-mode	12	1. Achieve stationary identity point with JET 2. Vary gas injection rate 3. In conjunction with AUG15-1.1-2, study power degradation and extend the existing identity match between AUG-W and JET-ILW 4. If time allows, establish improved H-mode at high rho-star (low plasma current) at the same values of q95, beta and nu-star to allow an assessment of the rho-star scaling of confinement by combining data from AUG and JET *Modelling/Analysis needs:* • *Core transport modelling (gyrokinetic)* • *Pedestal stability analysis,* • *EPED modelling and testing* • *Pedestal –core coupling* • *Confinement and ELM size scaling* • *SOL modelling on role of neutrals on pedestal stability and confinement* • *MHD modelling in aid of NTM avoidance*		H1.1_MST_D_16	part of M15-02 Hybrid scenario for DT
AUG15-1.1-4	The impact of helium ash on plasma confinement	14	1. Demonstrate effect on reactor relevant amount of He (5-20%) on pedestal, ELM behaviour/size and core profiles, beta dependence in Baseline and Improved H-mode scenarios 2. Investigate interplay with Helium and other impurity seeding 3. Pinpoint the physics reason for the observed confinement degradation due to helium 4. ensure good diagnostic coverage of the core and pedestal Helium profiles 5. Study shape dependence *Modelling/Analysis needs:* • *Helium plume emission modelling* • *Pedestal stability analysis and modelling* • *Core and edge gyrokinetic transport modelling*		H1.1_MST_D_14, H1.1_MST_D_15	B15-01 Effect of He on performance degradation
AUG15-1.1-5	Pedestal: avoiding the ballooning boundary	6	1. Test means to avoid the ballooning boundary (δ, β, gas, seeding) 2. Obtain good temperature and density pedestal profiles for data analysis *Modelling/Analysis needs:* • *Dynamic Pedestal stability analysis across the ELM cycle* • *Pedestal modelling coupled with SOL fluid modelling of effect of neutrals and seeding (eg SOLPS)*	**Joint with: TCV15-1.1-5**	H1.1_MST_D_4	M15-15 Avoiding the ballooning boundary

AUG15-1.1-7	Influence of gas injection on ICRF coupling	4	1. Provide best knowledge for ITER on the improvement of ICRF coupling by local gas injection, by getting the best experimental data, in particular SOL Te profiles (in additional to standardly available ne-profiles), to benchmark EMC3-Eirene 2. Further develop the gas injection technique to increase the ICRF coupling in ASDEX Upgrade by using alternative gas valves (ITPA IOS 5.2) *Modelling/Analysis needs:* • *The experiment (in L-mode) is oriented on achieving the best and simplest possible case for the EMC3-Eirene modeling.* • *Reciprocating Langmuir probe data should be analyzed.* • *The coupling relevant data should be integrated in the existing database.* • *Reflectometry data can be used to calculate the ICRF coupling improvement by simple models or by TOPICA and compare to experiment.*		H1.1_MST_D_9	
AUG15-1.1-8	Documentation of the effect of sawteeth on the core momentum and particle transport	14	1. Establish a low v* scenario with relatively low q95, good CXRS., long ST cycles 2. Document effectiveness of to remove impurities (He, B, N, Ne, Ar) 3. Test magnetic-reconnection models to explain rotation behaviour 4. Can changes to the rotation profile be explained by the redistribution of particles? 5. Compare TCV and AUG results at same low v* 6. Can we extrapolate to ITER with respect to the effectiveness of ST at expelling both momentum and particles from the core of the plasma? *Modelling/Analysis needs:* • *TRANSP runs for heat and torque deposition profiles and for modelling of the fast ions* • *Modelling of the magnetic reconnection occurring during the ST crashes.* • *He plume modelling* • *Convective particle transport analysis and modelling.* • *Low Z-impurity accumulation modelling*	**Joint with: TCV15-1.1-8**	H1.1_MST_D_11	
AUG15-1.1-9	ρ* scaling of intrinsic torque between JET and AUG	10	1. Establish NTM free match point for AUG 2. Compare the intrinsic torque with different heating systems (NBI versus ECRH) *Modelling/Analysis needs:* • *TRANSP analysis of the NBI torque.* • *Gyrokinetic simulations of the turbulence and comparison of the simulated and extracted intrinsic torque.* • *ASCOT modeling of the torque induced by fast ion losses in RMP experiment.*		H1.1_MST_D_20	Yes but JET part finished

Headline 1.2: Operation with reduced or suppressed ELMs (H. Meyer & M. Beurskens)						
AUG15-1.2-1	ELM mitigation using magnetic perturbations at low collisionality	36	1. Document the 3D response to n=2 ELM mitigation at low collisionality using rigid rotation for q95 = 3.8 with respect to plasma displacement (mid-plane versus X-point), target heat load pattern, fast ion loss. 2. Establish the access criteria for n=2 with respect to plasma collisionality ν* at the same density, perturbation strength (coil current), plasma rotation, q_{95} towards ELM mitigation at the ITER base-line q_{95} = 3. 3. Optimise the n=2 mitigation with respect to minimal confinement loss and tolerable ELM target load (ELM energy flux) including refuelling by pellet injection (pellet discharges ring fenced). 4. Extend the ELM mitigation at low collisionality towards the ITER base-line shape. *<u>Modelling and non AUG analysis:</u>* • *Analyse and compare existing MAST data including the effects on fast-ions to the AUG results and modelling.* • *Using various existing codes increase the understanding and predictive capability of the plasma response to non-axisymmetric perturbations with respect to: the sources and sinks in the momentum balance., the edge plasma stability including non-linear ELM modelling, the fast-ion transport and loss mechanisms.*	**Linked to: AUG15-He-2**	H1.2_MST_D_2, H1.2_MST_D_4, H1.2_MST_D_6, H1.2_MST_D_7, H1.2_MST_D_11, H1.2_MST_D_14, H1.7_MST_D_2	
AUG15-1.2-3	Operation close to the density limit with high confinement and tolerable ELMs	20	1. Develop a stable operating regime with small ELMs close to the density limit on AUG using two different approaches. • Exploit the findings of the recent ITER baseline experiments and investigate the influence of β_N on type-II ELMs. • If time permits exploit the findings from previous density limit experiments to establish stable operation with type-III ELMs (end of phase I) and compare to results from TCV15-1.2-3. 2. Investigate possibilities to extend the regimes to lower collisionality. <u>Potential modelling:</u> *Try to establish model based access criteria for the investigated small ELM regimes.*	**Joint with: TCV15-1.2-3**	H1.1_MST_D_1, H1.1_MST_D_19, H1.1_MST_D_28, H1.1_MST_D_30	
AUG15-1.2-4	Measurement of plasma response to magnetic perturbations using ECE	10	1. Establish ELM mitigation at low collisionality with n=2 at B_t > 2T. 2. Prove or disprove the existence of an island at the pedestal top and document the plasma response using rigidly rotating perturbations. 3. Compare measured plasma response with predictive theory (see modelling activity under AUG15-1.2-1).	**Linked to: AUG15-1.2-1**	H1.2_MST_D_17 H1.7_MST_D_2	

Headline 1.3: Avoidance and mitigation of disruption and runaways electrons (P. Martin & S. Coda)						
AUG15-1.3-1	Disruption mitigation via Massive Gas Injection	16	1. Define the role of injected gas quantity on the mitigation efficiency 2. Define the role of the number and position of valves in the mitigation process 3. Describe the role of intrinsic impurities on disruption dynamics 4. Perform MGI-mitigated (with several injected gases) disruption simulations with JOREK and/or other non-linear codes and validate numerical output against experimental data	**Joint with TCV15-1.3-1**	H1.3_MST_D_2, H1.3_MST_D_14 H1.3_MST_D_16	M15-17 Optimisation of disruption mitigation for high current operation and M15-18 Developing ITER-like Disruption mitigation scenario
AUG15-1.3-2	Disruption avoidance via applied magnetic perturbation	13	1. Main deliverable: reliable active control of the mode locking position, aiming for efficient ECRH/ECCD stabilizing action or to gain time for soft-landing, and with emphasis on dynamic techniques (lock mode entrainment to the rotating applied perturbation). Simulate the interaction between the applied magnetic perturbation and the mode: static (apply external perturbation to control locking position on a shot-by-shot basis), dynamic (lock mode entrainment to the rotating applied perturbation) 2. Lower priority: determine error field during low density and plasma current ramp. Compensate intrinsic error field with B-coils		H1.3_MST_D_7, H1.3_MST_D_9, H1.3_MST_D_13	
AUG15-1.3-3	Disruption avoidance using ECCD in high beta conditions	19	1. Establish the required steering precision and the tracking strategy on q=2 surface to define the optimum power deposition localization 2. Deploy new precursor signals in RT: Singular Value Decomposition disruption prediction algorithm (based on Mirnov coils, porting from FTU) 3. Determine the ECCD power threshold required for disruption avoidance 4. Perform density limit disruption avoidance in H-mode scenarios 5. Develop overall strategy for disruption avoidance including discharge soft shut down 6. Develop new strategy based on use of two gyrotrons on 3/2 and 2/1 resonant surfaces	**Joint with TCV15-1.3-3**	H1.3_MST_D_6, H1.3_MST_D_8	
AUG15-1.3-4	Disruption avoidance using the transport simulator RAPTOR	3	1. Implement a model-based plasma scenario supervision system based on RAPTOR that compares the physics expectation for the evolution of the plasma with diagnostic measurements, and the state of the plasma with known limits 2. Implement and test safe ramp-down strategies to actuate a soft-stop if threshold violations are detected.	**Joint with TCV15-1.3-4**	H1.3_MST_D_5	

AUG15-1.3-5	Runaway electrons: scenario, physics and mitigation via massive gas injection	19	1. Establish reliable scenario for runaway electron (RE) generation 2. Describe RE seed intensity (pre-existing fast electrons) with different mix of NBI/ECRH 3. Assess main physics and operational parameters that control RE generation scenario (e.g. current, Bt, MGI quantity and kind and how Res depends on them) 4. Determination of the critical field 5. Characterize RE mitigation via MGI (quantity and kind of gas, in particular with Neon, position of the valve) at different plasma currents 6. Simulate RE equilibrium, dynamics and losses in AUG and TCV discharges with various codes 7. Characterize the effect of MHD instabilities on runaway electron confinement	**Joint with TCV15-1.3-5**	H1.3_MST_D_3, H1.3_MST_D_10, H1.3_MST_D_11, H1.3_MST_D_15a H1.3_MST_D_15b H1.3_MST_D_17	M15-19 Mitigation of run-away with high Z material
AUG15-1.3-6	Runaway electrons: decorrelation via applied magnetic perturbation	13	1. Assess role of spontaneous MHD instabilities (e.g. kink, tearing) and in general of magnetic fluctuation on runaway electron confinement in enhancing RE decorrelation/losses occurring during the thermal quench or when the RE beam is fully formed. 2. Assess the impact of 3D helical deformations on RE decorrelation in response to RMPs. 3. Check if the RE beam is unstable/marginally unstable to n=1 modes like external kink/tearing and assess the possibility of coupling RMPs to such modes to produce resonant field amplification. 4. Effects on MHD stability/3D helical distortions of RE mitigation methods like MGI. 5. Simulations of the 3D equilibrium that forms with the application of RMP to the beam, of the RE transport and decorrelation, of the electromagnetic interaction of the RE beam with 3D wall structures	**Joint with TCV15-1.3-6**	H1.3_MST_D_3, H1.3_MST_D_17	M15-19 Mitigation of run-away with high Z material
Headline 1.4: integration of MHD control into plasma scenarios (P. Martin & S. Coda)						
AUG15-1.4-1	Plasma response to error fields at high beta and low-rotation	16	1. Development of scenario that allows operation above the no-wall limit 2. Quantitative assessment of plasma response to 3D fields with various spectra in high beta, low rotation scenarios close to or above the no-wall limit with high resolution measurements. 3. Understand the possible impact of intrinsic error fields on high-beta or low-rotation operation 4. Assess the effects on rotation and plasma performance as beta approaches the no-wall limit 5. Assess role of various driving/damping mechanisms in determining plasma stability	**Joint with TCV15-1.4-1**	H1.4_MST_D_4, H1.4_MST_D_9, H1.4_MST_D_10, H1.4_MST_D_14, H1.4_MST_D_21	

			6. Scan rotation (NBI/ICRH) to probe different kinetic effects on marginally stable kink mode 7. Study extension of operational boundaries in AUG 8. Development of error field measurements in high beta plasmas with a non-disruptive approach based on plasma response. 9. Comparison and benchmarking against numerical models (e.g. V3FIT/VMEC, MARS-K, M3D-C, CAFÉ,….) 10. Complete implementation of relevant AUG passive and active components in two 3D numerical codes, CAFE and CARIDDI. 11. Validate elements of RWM workflow (codes integrated into the WPCD frame) on the AUG data			
AUG15-1.4-2	Towards NTM control integration	12	1. Develop reliable EC-based stabilization tools for the 2/1 mode near disruptive boundaries	**Joint with TCV15-1.4-2**	H1.4_MST_D_3, H1.4_MST_D_6, H1.4_MST_D_7, H1.4_MST_D_17, H1.4_MST_D_19	
AUG15-1.4-3	Interaction between resonant magnetic perturbations and NTM stability	10	1. Describe the effect of external RMP on NTM dynamics and compare with results of other devices 2. Identify locking and unlocking threshold and hysteresis 3. Study NTM stabilization by RMPs 4. Assess braking due to applied resonant and non-resonant magnetic perturbation 5. Assess the possibility of improving EC-based NTM control by means of synergy with externally applied magnetic perturbation 6. Modelling of NTM evolution to compare with experimental data (including developments in particular on the interaction of NTM with RMP)		H1.4_MST_D_1 H1.4_MST_D_5 H1.4_MST_D_20 H1.4_MST_D_22	
Headline 1.5: Control of core contamination and dilution from W PFCs (M. Beurskens & H. Meyer)						
AUG15-1.5-1	Mitigation of central tungsten accumulation through combined central ECRH and tailoring of MHD activity in high performance H-modes	10	1. Understand the physics behind W transport and control in the presence of ECRH and saturated MHD activity. 2. Continue and extend work performed in 2014 to high power/performance discharges. <u>*Modelling and analysis needs:*</u> • *GENE - simulations of turbulent stability in the non-axisymmetric geometry of the displaced core of a (1,1) mode.* • *EUTERPE - simulations of neoclassical transport in the non-axisymmetric geometry of the displaced core of a (1,1) mode.* • *DKES - calculation of mono-energetic transport coefficients to be used in a*	**Joint with TCV15-1.5-1**	H1.5_MST_D_2	

			transcport code for the calculation of radial electric field required in EUTERPE. • *XTOR-2F - simulation of mode-impurity coupling, electron and impurity density redistribution during mode saturation and at sawtooth crash.* • *TRANSP - evaluation of fast particle fraction and heating deposition profiles.* • *STRAHL - simulations of mode-averaged W transport.* • *Tomographic reconstructions of SXR data.* • *2D mode-resolved mapping of 1D fast-ECE data.* • *Calculation of the 2D mode-resolved intrinsic W density.*			
AUG15-1.5-3	ICRF-related modifications of SOL density, ion energy and particle transport	10	1. Characterize modifications of density and mean ion energy profiles on the field lines connected to new 3-strap antennas. 2. Use antenna embedded reflectometry to obtain data for validation of the TOPICA simulation tool (RF properties) 3. Explore the effect of the SOL transport modified by ICRF on the penetration of light impurities from the outer wall to the confined plasma. <u>*Modelling and analysis needs:*</u> • *The experimental data should be linked with the electromagnetic and sheath model calculations. TOPICA and SSWICH calculations are required.* • *Reciprocating RFA probe data and antenna reflectometry (if available) should be analyzed.* • *Analysis of Ar and N2 levels in the plasma is required.*		H1.5_MST_D_5, H1.5_MST_D_6, H1.1_MST_D_9	
Headline 1.6: Determine optimum particle throughput for reactor scenarios (T. Eich & M. Beurskens)						
AUG15-1.6-1	Preditictive particle exhaust with pumps	8	1. Test of particle throughput in conditions matching the foreseen ITER pumping capabilities 2. Make use of different cryo-pump capabilities in AUG (full, 1/3, off) 3. 2D- and 3D modelling for DSMC (Direct Simulation Monte Carlo, KIT) 4. Run simple L-mode cases with different cryo-pumping and puffing		H1.6_MST_D_1	
Headline 1.7: Optimise fast ion confinement and current drive (H. Meyer & S. Coda)						
AUG15-1.7-1	Neutral beam current drive studies	6	1. Based on the experiments in AUG14-1.7-1, exploit new diagnostic capabilities to further quantify the fast-ion redistribution during on- and off-axis NBCD. 2. Modify the E/T_e ratio at constant heating power to investigate the potential importance of turbulent transport. 3. If time permits, investigate the effect of off-axis NBI on the fast-ion, current and heat-deposition profiles using NBI modulation. 4. Compare results to TCV15-1.7-1 and TCV15-1.7-4. <u>*Modelling:*</u> *In 2016 if available benchmark IMAS/WPCD integrated fast-ion modelling workflow to be developed within WPCD in 2015.*	**Joint with TCV15-1.7-1**	H1.7_MST_D_5, H1.7_MST_D_12	

AUG15-1.7-2	Active control of Alfvén Eigenmodes using ECRH/ECCD, ICRH and RMPs	20	1. Investigate impact of localized ECRH / ECCD on both NBI and RF tail driven Alfvén Eigenmode (AE) activity in support of ITPA EP-7. Document change in AE stability with ECRH injection location and EP distribution. Document resultant change in EP profiles and EP transport. Improve understanding of ECRH / ECCD stabilization of RSAEs. 2. Investigate the potential for ICRH beat waves to control the fast ion population and control AE. 3. Investigate the potential to control AE by the application of non-resonant magnetic perturbations. *Modelling:* • *Model fast-ion transport, loss and interaction with ICRH using existing codes such as LIGKA/HAGIS, ASCOTT, Gourdoun, PION, SELFO etc.* • *In 2016 if available possibly benchmark IMAS/WPCD integrated fast-ion modelling workflow to be developed within WPCD in 2015.*		H1.7_MST_D_1, H1.7_MST_D_3, H1.7_MST_D_19, H1.7_MST_D_17	
AUG15-1.7-3	Redistribution of fast ions during sawteeth	12	1. In continuation of AUG14-1.7-3, quantify the fast-ion redistribution level vs. inversion radius, sawtooth period, and crash amplitude 2. Generate a 2D velocity-space tomography of the fast ion redistribution during sawtooth crashes using 2 view CTS and 5 view FIDA data. 3. Compare the fast ion redistribution at the high field side (CTS) with low field side measurements (FIDA). 4. Quantify the fast-ion redistribution of trapped particles during sawtooth crashes. 5. If possible perform piggy back tests of acceleration of fast-ions by 3rd harmonic ICRH *Modelling and non AUG analysis tasks:* • *Analyse existing MAST data with respect to fast-ion redistribution by sawteeth and compare to model predictions and AUG findings.* • *Model acceleration of NBI ions by 3rd harmonic ICRH predictively and if possible compare to possible data collected in piggy back.*		H1.7_MST_D_4, H1.7_MST_D_6, H1.7_MST_D_13, H1.7_MST_D_15, H1.7_MST_D_17	

AUG15-1.7-5	Quantification of the slowing down and confinement of energetic helium injected with helium beams	8	1. Measure the slowing down of fast He ions in D plasmas using He doped NBI. 2. Compare the dependence of the slowing-down on collisionality and compare with the theoretical predictions. 3. Compare the behaviour of the fast He to thermal He and fast D.		H1.7_MST_D_11	
Headline 1.8: Develop integrated scenarios with controllers (S. Coda & P. Martin)						
AUG15-1.8-1	Integrated control of multiple discharge parameters	24	1. Demonstrate integrated control of three or more among NTMs, sawteeth, ELMs, disruption mitigation and divertor detachment, using diagnostic observers + real-time modelling and assessing minimal necessary observer set. 2. Demonstrate robustness of actuator sharing algorithm to actuator failure, and rational prioritization. *Modelling and analysis needs:* • *Control engineering modelling to assist development of MIMO algorithms* • *RAPTOR modelling to predict plasma response*	**Joint with TCV15-1.8-1**	H1.8_MST_D_7, H1.8_MST_D_5, H1.4_MST_D_18	
AUG15-1.8-3	Position control by reflectometry	6	1. Use both inner (HFS) and outer (LFS) reflectometry separatrix position estimates for plasma position/shape control		H1.8_MST_D_3	
Headline 2.1: Detachment control for the ITER and DEMO baseline strategy (T. Eich & M. Beurskens)						
AUG15-2.1-1	High P_{sep}/R studies with mixed impurities	32	1. Optimise impurity mix for divertor and mantle radiation 2. Develop and test relevant sensors and actuators for detachment detection and control		H2.1_MST_D_4, H2.1_MST_D_10, H2.1_MST_D_13	M15-20 Seeding to maximum radiated fraction towards high Psep/R M15-21 Dynamics and stability of divertor detachment
AUG15-2.1-2	Radiation in 3D SOL	16	1. A validated model to describe the power exhaust capabilities with magnetic perturbations in impurity seeded H-mode discharges 2. Make use of ELM free conditions to improve the understanding and input for modelling (much easier diagnostic interpretation) 3. Apply low frequency rotation to study the 3D SOL structure		H2.1_MST_D_4, H2.1_MST_D_10	

AUG15-2.1-3	Detachment studies	16	1. Investigate/document confinement at detachment for different fuelling methods / locations 2. Benchmark codes to predict detachment, particle and power loads in ITER and DEMO	**Joint with TCV15-2.1-3**	H2.1_MST_D_1, H2.1_MST_D_7, H2.1_MST_D_8, H2.1_MST_D_11, H2.1_MST_D_12	M15-21 Dynamics and stability of divertor detachment B15-09 L-mode impurity-seeding studies for power exhaust predictions
Headline 2.2: Prepare efficient PFC operation for ITER and DEMO (T. Eich & H. Meyer)						
AUG15-2.2-1	Power handling on castellated divertor	16	1. Eliminate the uncertainty in the IR data due to insufficient spatial resolution 2. Use a simpler geometry to advance understanding of previous experimental results 3. Study the physics of vapour shielding in a less ambiguous geometry		H2.2_MST_D_11, H2.2_MST_D_12	M15-32 Investigation of heat flux mitigation factor and of W melting by ELMs
AUG15-2.2-2	Nitrogen migration and implantation in first wall	16	1. Validate codes for plasma wall interactions (erosion, re-deposition and migration) 2. Study the long range transport of impurities from the divertor to the main chamber by seeding 15N 3. Measure the 15N deposition on samples exposed at the AUG-MEM using ion beam analysis 4. Interpret the results using the WallDYN code 5. Perform trace injections of neon(short blips as well as longer bleeds) from various poloidal locations at various injection rates and measure spectroscopically the poloidally resolved dynamics		H2.2_MST_D_9, H2.2_MST_D_14	
AUG15-2.2-3	Filamentary transport in the SOL	20	1. Assess scenarios suitable for minimisation of divertor and main chamber erosion 2. Quantify and (try to) extrapolate main chamber filamentary transport , i.e. expected particle flux and energy 3. Understand mechanism forming the flat region known as ”density shoulder” in the far SOL	**Joint with TCV15-2.2-3**	H2.2_MST_D_4, H2.2_MST_D_6, H2.2_MST_D_13, H2.2_MST_D_16, H2.2_MST_D_18, H2.3_MST_D_1, H2.3_MST_D_2	

AUG15-2.2-5	Metallic Dust Mobilization	11	1. Obtain first experimental evidence of dust motion inside the gaps of ITER castellated PCFs and of dust remobilization from adjacent monoblocks 2. Evaluate whether gaps constitute a dust accumulation site and identify the physical mechanism that induces the amassment 3. Evaluate the gap trapping efficiency and investigate the possibility of saturation		H2.2_MST_D_2, H2.2_MST_D_15	Modelling part M15-32 Investigation of heat flux mitigation factor and of W melting by ELMs. Connected to JET task T15-08 Dust analysis
Headline2.3: Optimise predictive models for ITER and DEMO divertor/SOL (T. Eich & H. Meyer)						
AUG15-2.3-1	Power loading on first wall due to ELMs	20	1. Measure in/out ELM heat load asymmetries in full-W AUG and compare with TCV 2. Compare to ELM heat load scaling based on pedestal pressure 3. Establish scaling of ELM heat load to first wall by comparing TCV & AUG and ideally making use of older JET-C and newer COMPASS data	**Joint to TCV15-2.3-1**	H2.3_MST_D_5, H2.1_MST_D_2, H2.2_MST_D_4, H2.2_MST_D_5, H2.2_MST_D_17	M15-28 Extend scalings of ELM power loads and of SOL width to inner divertor andf irst wall
Experiments in HELIUM						
AUG15-He-1	Establish low ELM frequency scenario in Helium *[Headline 1.2]*	16	1. Try to develop a scenario in < 95% He plasmas with low ELM frequency and low density/collisionality suitable for ELM mitigation. 2. Characterise the pedestal in consecutive discharges with low gas puffing to reduce recycling. 3. Test ELM mitigation using simple recipies based on vacuum calculations.			
AUG15-He-2	ELM mitigation experiment in Helium *[Headline 1.2]*	16	1. Perform differential phase scan of n=2 perturbations to explore the ELM mitigation in pure He plasmas. 2. If successful assess the transferability of ELM mitigation in D to ELM mitigation in He and vica versa. 3. If successful compare the ELM mitigation results in He to ELM mitigation in D. *Modelling: Use modelling performed under AUG15-1.2-1 to "predict" the best RMP configuration for ELM mitigation.*	**Linked to AUG15-1.2-1**	H1.2_MST_He_2	
AUG15-He-3	ITER baseline scenario in Helium *[Headline 1.1]*	8	1. Establish low ELM frequency scenario at q95~3 and 3.6 2. Attempt ELM mitigation with RMP and Pellets 3. Study resilience to W accumulation		H1.1_MST_He_6	

AUG15-He-4	Tungsten transport in Helium *[Headline 1.5]*	4	Conditional experiment in case data from AUG15-He-1 and AUG15-He-3 proof insufficient 1. Study W tansport in low ELM frequency H-mode plasmas (compare to D reference) 2. Attempt W accumulation mitigation with central heating		H1.5_MST_He_1	
AUG15-He-5	Disruption mitigation in Helium *[Headline 1.3]*	4	1. Explore Massive gas injection efficiency for disruption mitigation in He plasmas 2. specifically study the radiation efficiency of impurity injection			
AUG15-He-6	Tunsten fuzz and power load studies in Helium *[Headline2.2]*	16	1. Study local migration of impurities in the outer divertor with the help of an 15N/18O injection experiment 2. Investigate the formation of tungsten nitrides/oxides 3. Model the outcomes of the experiment using OSM, SOLPS, and ERO		H2.2_MST_He_2	
AUG15-He-7	Pedestal seeding studies in Helium *[Headline 1.1]*	4	1. Study the impact of low Z impurity seeding on the pedestal confinement and stability 2. Vary shaping and β_N in power scan		H1.1_MST_He_4	
AUG15-He-8	Optimised divertor pumping in Helium *[Headline 1.6]*	4	1. Optimise divertor pumping in Helium		H1.6_MST_He_1	
AUG15-He-9	Detachment studies in Helium *[Headline 2.1]*	8	1. Optimise impurity mix for divertor and mantle radiation 2. Develop and test relevant sensors and actuators for detachment detection and control		H2.1_MST_He_1	
AUG15-He-10	He-ICWC for D removal and surface modification studies *[Headline 2.2]*	0	To be scheduled during a technical shot day in the He campaign		H2.2_MST_He_4	

III.2. List of MST1-TCV experiments

Note: experiments in Helium are not listed by Headline but separately at the end of the table

MST1-TCV experiment Id	MST1-TCV experiment title	Number of shots	MST1-TCV experiment Deliverables	Related MST1 experiment	Based on proposals	Related JET experiment
Headline1.1: Increase the margin to achieve high fusion gain on ITER (M. Beurskens & H. Meyer)						
TCV15-1.1-1	ITER baseline confinement and development of alternative scenarios	20	1. Study confinement in type I ELMy H-mode operation at low P_{sep}/P_{LH} 2. Study the effect of plasma triangularity 3. Test effect of change of heatng mix (ECRH vs NBI) *<u>Modelling/Analysis needs:</u>* • *Transp* • *Pedestal stability analysis,* • *EPED modelling and testing* • *ELM analysis,* • *Core energy and impurity transport (most likely gyrokinitec),* • *Confinement and ELM size scaling* • *-SOL modelling on role of neutrals on pedestal stability and confinement*	**Joint with AUG15-1.1-1**	H1.1_MST_D_18, H1.1_MST_D_32, H1.2_MST_D_3	M15-08 Integrating the building blocks of the ITER scenario
TCV15-1.1-2	Seeding and fuelling; effect on energy confinement and power degradation	20	1. Study the influence of impurity seeding on the confinement in a C-wall device as a referece for metal wall devices (JET and AUG) 2. Study power degradation of confinement in seeded and unseeded plasmas 3. Study impact of triangularity *<u>Modelling/Analysis needs:</u>* • *Pedestal stability analysis* • *EPED modelling and testing* • *Impurity radiation analysis and modelling* • *ELM analysis,* • *Core energy and impurity transport (most likely gyrokinitec),* • *Confinement and ELM size scaling*	**Joint with AUG15-1.1-2**	H1.1_MST_D_10, H1.1_MST_D_21, H2.1_MST_D_13	M15-22 Impact of seeding gases on recycling behaviour, radiation pattern, pedestal and detachment
TCV15-1.1-5	Pedestal: avoiding the ballooning boundary	24	1. Test means to avoid the ballooning boundary (δ, β, gas, seeding) 2. Obtain good temperature and density pedestal profiles for data analysis *<u>Modelling/Analysis needs:</u>* • *Dynamic Pedestal stability analysis across the ELM cycle* • *Pedestal modelling coupled with SOL fluid modelling of effect of neutrals and seeding (eg SOLPS)*	**Joint with AUG15-1.1-5**	H1.1_MST_D_4	M15-15 Avoiding the ballooning boundary

TCV15-1.1-6	Pedestal: effect of triangularity on confinement	20	1. Establish Type I ELMy H-mode plasmas for a wide range of negative to positive δ 2. Obtain good temperature and density pedestal profiles for stability analysis *Modelling/Analysis needs:* • *Test EPED predicitive pedestal model across extreme triangularity variation* • *Pedestal stability analysis across the ELM cycle* • *Pedestal modelling coupled with SOL fluid modelling of effect of neutrals and seeding (eg SOLPS)*		H1.1_MST_D_8, H1.2_MST_D_5	
TCV15-1.1-8	Documentation of the effect of sawteeth on the core momentum and particle transport	25	1. Establish a low ν* scenario with relatively low q95, good CXRS., long ST cycles 2. Document effectiveness of to remove impurities (He, B, N, Ne, Ar) 3. Test magnetic-reconnection models to explain rotation behaviour 4. Can changes to the rotation profile be explained by the redistribution of particles? 5. Compare TCV and AUG results at same low ν* 6. Can we extrapolate to ITER with respect to the effectiveness of ST at expelling both momentum and particles from the core of the plasma? *Modelling/Analysis needs:* • *TRANSP runs for heat and torque deposition profiles and for modelling of the fast ions* • *Modelling of the magnetic reconnection occurring during the ST crashes.* • *Convective particle transport analysis and modelling.* • *Low Z-impurity accumulation modelling*	**Joint with AUG15-1.1-8**	H1.1_MST_D_11	
TCV15-1.1-10	Transport-driven toroidal rotation in H-mode plasma edge	15	1. Collect experimental data on the link between intrinsic toroidal rotation and plasma confinement properties in H-mode 2. Validation of the theory of toroidal rotation generation mechanism at plasma edge 3. Exploring the physics of core intrinsic rotation via modification of shaping and the rotation boundary conditions *Modelling needs: Neoclassical modeling in order to estimate the flux-averaged deuterium rotation*		H1.1_MST_D_3	
Headline 1.2: Operation with reduced or suppressed ELMs (H. Meyer & M. Beurskens)						
TCV15-1.2-2	ELM mitigation using edge ECRH	24	1. Transfer the ELM control with edge ECRH observed in pear shaped plasmas to standard SND plasmas towards ITER-like shapes. 2. If successful, characterise the higher frequency ELMs with respect to their heat load mitigation potential. *Modelling:*		H1.2_MST_D_15	

			• *Model the ECRH deposition using standard ray and beam tracing codes: TORAY, C3PO, TORBEAM; quasilinear Fokker-Planck codes: CQL3D, LUKE.* • *Model the edge stability and compare to standard type-I ELM models.* • *Assess the potential for ELM mitigation on ITER or DEMO using edge ECRH.*			
TCV15-1.2-3	Operation close to the density limit with high confinement and tolerable ELMs	20	1. Explore the four phases of the density as observed on AUG. 2. Develop a stable operating regime with small ELMs and high confinement close to the density limit on TCV based on the AUG experience. Try to establish a high confinement type-III ELM regime at the end of phase 1 of the density limit. 3. Investigate possibilities to extend the regimes to lower collisionality. *Potential modelling:* *Try to establish model based access criteria for the investigated small ELM regimes.*	**Joint with AUG15-1.2-3**	H1.1_MST_D_1, H1.1_MST_D_19, H1.1_MST_D_28, H1.1_MST_D_30	
TCV15-1.2-5	ELM pacing with vertical kicks	20	1. Assess the ELM pacing potential with vertical kicks in TCV NBI Hmodes. 2. Assess the role of the displacement amplitude vs. velocity in the edge stability. 3. Characterise the target heat load mitigation potential of ELMs paced by vertical displacements on TCV. *Modelling:* 1. Combine time series and stability analysis to probe the stability boundary during vertical kicks.		H1.2_MST_D_16, H1.2_MST_D_18	
Headline 1.3: Avoidance and mitigation of disruption and runaways electrons (P. Martin & S. Coda)						
TCV15-1.3-1	Disruption mitigation via massive gas injection	26	1. Define the role of injected gas quantity and quantify minimum quantity for efficient mitigation 2. Quantify radiation asymmetries 3. Describe the role of MHD (and in particular of the m=1,n=1 mode) during the thermal quench. Quantify degradation of mitigation efficiency with increasing gap size (distance valve-plasma) 4. Assess the role of e-i equipartition time on the radiation fraction 5. Perform MGI-mitigated (with several injected gases) disruption simulations with JOREK and/or other non-linear codes and validate numerical output against experimental data	**Joint with AUG15-1.3-1**	H1.3_MST_D_2, H1.3_MST_D_14, H1.3_MST_D_16 H1.3_MST_D_21	M15-17 Optimisation of disruption mitigation for high current operation and M15-18 Developing ITER--like Disruption mitigation scenario
TCV15-1.3-3	Disruption avoidance using	20	1. Establish the tool in the TCV device and determine the ECCD power threshold required for disruption avoidance	**Joint with AUG15-1.3-3**	H1.3_MST_D_6, H1.3_MST_D_8	

	ECCD in high beta conditions		2. Scan of plasma elongation, to see change in required power for avoidance 3. Explore different plasma shaping to assess shaping dependence of ECCD power needed for avoidance 4. Deploy new precursor signals in RT: Singular Value Decomposition disruption prediction algorithm (based on Mirnov coils, porting from FTU)			
TCV15-1.3-4	Disruption avoidance using the transport simulator RAPTOR	10	1. Implement a model-based plasma scenario supervision system based on RAPTOR that compares the physics expectation for the evolution of the plasma with diagnostic measurements, and the state of the plasma with known limits . 2. Implement and test safe ramp-down strategies to actuate a soft-stop if threshold violations are detected.	**Joint with AUG15-1.3-4**	H1.3_MST_D_5	
TCV15-1.3-5	Runaway electrons: scenario, physics and mitigation via massive gas injection	52	1. Establish reliable scenario for runaway electron (RE) generation 2. Assess main physics and operational parameters that control RE generation scenario (e.g. current, Bt, MGI quantity and kind/how Res depends on them) 3. Determination of the critical field 4. Characterize RE mitigation via MGI 5. Simulate RE dynamics and losses in AUG and TCV discharges with various codes 6. Describe effect of shaping (aspect ratio/elongation) on RE generation and mitigation/suppression 7. Characterize the effect of MHD instabilities on runaway electron confinement 8. Assess the possibility of controlling the position of the RE beam via current ramp-down, and integrate it with MGI RE suppression/mitigation	**Joint with AUG15-1.3-5**	H1.3_MST_D_3, H1.3_MST_D_10, H1.3_MST_D_11, H1.3_MST_D_15a, H1.3_MST_D_15b H1.3_MST_D_17 H1.3_MST_D_19	M15-19 Mitigation of run-away with high Z material

TCV15-1.3-6	Runaway electrons: decorrelation via applied magnetic perturbation	13	1. Assess role of spontaneous MHD instabilities (e.g. kink, tearing) and in general of magnetic fluctuation on runaway electron confinement in enhancing RE decorrelation/losses occurring during the thermal quench or when the RE beam is fully formed. 2. Assess the impact of 3D helical deformations on RE decorrelation in response to RMPs. 3. Check if the RE beam is unstable/marginally unstable to n=1 modes like external kink/tearing and assess the possibility of coupling RMPs to such modes to produce resonant field amplification. 4. Effects on MHD stability/3D helical distortions of RE mitigation methods like MGI. 5. Assess the possibility of controlling the position of the RE beam via current ramp-down, and integrate it with MGI RE suppression/mitigation 6. Simulations of the 3D equilibrium and of the RE transport and decorrelation in presence of MHD activity.	**Joint withAUG15-1.3-6**	H1.3_MST_D_3, H1.3_MST_D_17, H1.3_MST_D_19	M15-19 Mitigation of run-away with high Z material
Headline 1.4: integration of MHD control into plasma scenarios (P. Martin& S. Coda)						
TCV15-1.4-1	Plasma response and error fields at high beta and low-rotation	22	1. Development of scenarios that allows to operate above the no-wall limit (towards Advanced Tokamak regimes), also with the help of RAPTOR 2. Quantitative assessment of plasma response in high beta, low rotation scenarios close or above the no-wall limit with high resolution measurements. 3. Understand the possible impact of intrinsic error fields on high-beta or low-rotation operation 4. Assess the effects on rotation and plasma performance as beta approaches the no-wall limit 5. Assess role of various driving/damping mechanisms in determining plasma stability 6. Scan rotation to probe different kinetic effects on marginally stable kink modes 7. Comparison and benchmarking of high beta MHD behaviour against numerical models (e.g. V3FIT/VMEC, MARS-K, M3D-C, CAFÉ,….)	**Joint with AUG15-1.4-1**	H1.4_MST_D_4, H1.4_MST_D_9, H1.4_MST_D_10, H1.4_MST_D_14, H1.4_MST_D_21	

TCV15-1.4-2	Towards NTM control integration	30	1. Develop integrated NTM real-time control for pre-emption and stabilisation for both 3/2 and 2/1 modes 2. Develop reliable EC-based stabilization tools for the 2/1 mode near disruptive boundaries 3. Compare with numerical simulations and predictions	**Joint with AUG15-1.4-2**	H1.4_MST_D_3, H1.4_MST_D_6, H1.4_MST_D_17, H1.4_MST_D_19	
TCV15-1.4-4	Advanced NTM physics	16	1. Develop scaling on rotation for marginal beta threshold with combined data from AUG and TCV 2. Extend data base at low rotation with TCV data and clarify difference in NTM onset threshold at low rotation between DIII-D and AUG. 3. Four-machine scaling by extending the database with old MAST and JET data. 4. Explore slow plasma rotation to understand the destabilization of NTM under central ECH/ECCD in the absence of seed islands with the aim of avoiding the mode appearance in both elongated and circular plasma shapes 5. Understanding of the role of EC torque on plasma rotation		H1.4_MST_D_5, H1.4_MST_D_13, H1.4_MST_D_15, H1.4_MST_D_16	
TCV15-1.4-5	Advanced sawtooth physics	18	1. Test sawtooth control (locking, pacing) methods in high beta conditions 2. Test both destabilization and stabilization control 3. Explore physics of the seed island formation after the sawtooth crash at varying beta, with different rotation profiles and sawtooth crash amplitude		H1.4_MST_D_8 H1.4_MST_D_11,	
Headline 1.5: Control of core contamination and dilution from W PFCs (M. Beurskens & H. Meyer)						
TCV15-1.5-1	Mitigation of high Z impurity accumulation through combined central ECRH and tailoring of MHD activity in high performance H-modes	15	1. Understand the physics behind transport of W and other impurities and its control in the presence of ECRH and saturated MHD activity. 2. Continue and extend work performed in 2014 to high power/performance discharges.	**Joint with AUG15-1.5-1**	H1.5_MST_D_2	
TCV15-1.5-2	Effect of the poloidal asymmetries on impurity transport	15	1. Determine the role of impurity asymmetry on transport of W and other impurities 2. Continue and extend work performed in 2014 to study transport effects		H1.5_MST_D_3	
Headline 1.7: Optimise fast ion confinement and current drive H. Meyer & S. Coda						

TCV15-1.7-1	Neutral beam current drive studies	10	1. Based on the experience on AUG establish scenarios to compare on- and off-axis NBCD on TCV exploiting vertical shifts and core ECRH heating. Try to avoid core MHD by operating with $q_{min} > 1$ using off-axis ECCD. 2. If possible use beam modulation to quantify the fast-ion, current drive and heat deposition profiles.	**Joint with AUG15-1.7-1**	H1.7_MST_D_5, H1.7_MST_D_12	
TCV15-1.7-4	Role of 3D EM/ES turbulence in fast ion confinement and neutral beam current drive	30	1. Determine the 3D EM+ES turbulence characteristics in Ohmic plasmas as function of plasma current at fixed q_{95}, q_{95} at fixed plasma current. 2. Characterise the 3D EM+ES turbulence and its effect on fast-ion redistribution and NBCD in 2 extreme cases of the Ohmic scans by varying pulse duration, injection energy, injection angle, deposition location. 3. Assess the fast particle production due to reconnection events in above scans. *Modelling: Compare turbulence characteristics and fast ion confinement with code predictions.*		H1.7_MST_D_7, H1.7_MST_D_9	
Headline 1.8: Develop integrated scenarios with controllers (S. Coda & P. Martin)						
TCV15-1.8-1	Integrated control of multiple discharge parameters	35	1. Demonstrate integrated control of three or more among NTMs, sawteeth, ELMs, disruption mitigation and divertor detachment, using diagnostic observers + real-time modelling and assessing minimal necessary observer set. 2. Demonstrate robustness of actuator sharing algorithm to actuator failure, and rational prioritization. *Modelling and analysis needs:* • *Control engineering modelling to assist development of MIMO algorithms* • *RAPTOR modelling to predict plasma response*	**Joint with AUG15-1.8-1**	H1.8_MST_D_7, H1.8_MST_D_5, H1.4_MST_D_18	
TCV15-1.8-2	Pasma control through real-time modelling	10	1. Use model-based design for routine use of profile controllers in multiple experiments 2. Extend model-based reconstruction (RAPTOR) to ne and Te profile reconstruction on TCV 3. Provide a tool to design and simulate profiles controllers for various quantities (first Te, ne, then q) 4. Use established Robust/Predictive control tools, include actuator limits		H1.8_MST_D_1	
Headline 2.1: Detachment control for the ITER and DEMO baseline strategy (T. Eich & M. Beurskens)						
TCV15-2.1-3	Detachment studies	40	1. Investigate/document confinement at detachment for different fuelling methods / locations 2. Benchmark codes to predict detachment, particle and power loads in ITER and DEMO	**Joint with AUG15-2.1-3**	H2.1_MST_D_1, H2.1_MST_D_7, H2.1_MST_D_8, H2.1_MST_D_11, H2.1_MST_D_12	M15-20 Seeding to maximum radiated fraction towards high Psep/R

						M15-21 Dynamics and stability of divertor detachment
TCV15-2.1-4	Divertor power load studies in single null configuration	30	1. Comparing power width with multi-machine data base 2. Making use of variable magnetic configuration to study the S- factor and its impact on ELM heat loads (shaping effects) 3. Contribute to understanding of S-factor w.r.t. to target electron temperatures and comparison open/closed divertor	**TCV15-He-11**	H2.1_MST_D_2, H2.1_MST_D_3	
Headline 2.2: Prepare efficient PFC operation for ITER and DEMO (T. Eich & H. Meyer)						
TCV15-2.2-3	Filamentary transport in the SOL	40	1. Assess scenarios suitable for minimisation of divertor and main chamber erosion 2. Quantify and (try to) extrapolate main chamber filamentary transport , i.e. expected particle flux and energy 3. Understand mechanism forming the flat region known as ”density shoulder” in the far SOL	**Joint with AUG15-2.2-3** **Linked to TCV15-He-12**	H2.2_MST_D_4, H2.2_MST_D_6, H2.2_MST_D_13, H2.2_MST_D_16, H2.2_MST_D_18, H2.3_MST_D_1, H2.3_MST_D_2	
TCV15-2.2-4	SOL power width in limiter configurations	20	1. Complementary studies proposed and foreseen for AUG moved to internal IPP program. Team urged to collaborate strongly 2. Determine the nature of the short and long scale lengths of the heat flux in the SOL 3. Determine whether the two-scale effect is present on the LFS as well or if it is only measurable on the HFS 4. Determine whether it is a universal feature of limited plasmas or not 5. Compare the results with nonlinear fluid simulations (GBS code) including shaping effects	**Linked to TCV15-He-13**	H2.2_MST_D_1, H2.3_MST_D_4	
Headline2.3: Optimise predictive models for ITER and DEMO divertor/SOL (T. Eich & H. Meyer)						
TCV15-2.3-1	Power loading on first wall due to ELMs	40	1. Measure type-I ELM heat loads in TCV 2. Measure in/out ELM heat load asymmetries in TCV and compare to full W AUG. 3. Compare to ELM heat load scaling based on pedestal pressure 4. Establish scaling of ELM heat load to first wall by comparing TCV & AUG and ideally making use of older JET-C and newer COMPASS data	**Joint with AUG15-2.3-1**	H2.3_MST_D_5, H2.1_MST_D_2, H2.2_MST_D_4, H2.2_MST_D_5, H2.2_MST_D_17	M15-28 Extend scalings of ELM power loads and of SOL width to inner divertor andfirst wall
TCV15-2.3-2	Power width dependence on triangularity	20	1. Measure power width with negative triangularity 2. Ideally scan from ‘normal’ to negative triangularity 3. Make use of inverse currents from shot to shot in TCV to change the drift	**Linked to TCV15-He-15**	H2.3_MST_D_3	

			direction w.r.t to helicity			
Headline2.4: Investigate alternative power exhaust solutions for DEMO (T. Eich, H. Meyer & S. Coda)						
TCV15-2.4-1	Detachment optimisation in snowflake configuration	40	1. Assess the optimal SF (SF+, SF-) configuration to minimise the target heat load in attached conditions. 2. Characterise the access to full detachment in the optimum SF configuration and compare to standard SF divertor configuration 3. Study core performance for pronounced partial detachment 4. When done, study detachment with help of impurity seeding (N2 etc.) *<u>Modelling:</u> Compare experimental results to EMC3-EIRENE and SOLEDGE2D-EIRENE calculations.*		H2.4_MST_D_2, H2.4_MST_D_4, H2.4_MST_D_7	
TCV15-2.4-2	SOL transport in snowflake configuration	40	1. Characterise the cross field transport in the divertor to understand the power distribution between the different strike points of the SF configuration. 2. Compare the inter ELM and ELM SOL cross field transport between SF and standard divertor configurations to extrapolate first wall heat loads to future devices 3. Compare the cross field transport to AUG and MAST in continuation of MST1-T14-8 (analysis of MAST data)		H2.4_MST_D_1, H2.4_MST_D_2	
TCV15-2.4-3	Characterisation of advanced divertor configurations	60	1. Establish divertor configurations with outer strike point radius including Super-X (outer strike point on the outer wall) and double decker, but similar core shape. 2. Assess the upstream density for detachment at different levels of auxiliary heating power and different flux expansion at the target. 3. Assess the access to H-mode in all divertor configurations with different strike point radius 4. Study detachment in advanced divertor configuration (extend to seeding) 5. Study core performance for pronounced partial detachment		H2.4_MST_D_3, H2.4_MST_D_6	
Experiments in HELIUM						
TCV15-He-10	MHD control in Helium *[Headlines 1.4, 1.8]*	20	1. Test sawtooth control (locking, pacing) methods in high beta (majority D, 10-20% He) and He plasmas 2. Test both destabilization and stabilization control 3. Include real-time RAPTOR simulation with sawtooth module to test its reliability 4. Compare with sawtooth control in D plasmas and effects of impurities 5. Test He core transport and link with sawteeth and central EC heating 6. Check that the most tried-and-tested controllers (NTM + ELMs + sawteeth)		H1.4_MST_He_1, H1.8_MST_He_1	

			work in He, not necessarily together			
TCV15-He-11	Divertor power load studies in single null configuration in Helium *[Headline 2.1]*	10	1. Comparing power width with multi-machine data base 2. Making use of variable magnetic configuration to study the S- factor and its impact on ELM heat loads (shaping effects) 3. Contribute to understanding of S-factor w.r.t. to target electron temperatures and comparison of open/closed divertor	**Linked with TCV15-2.1-4**	H2.1_MST_D_2, H2.1_MST_D_3	
TCV15-He-12	SOL filamentary transport in Helium *[Headline 2.2]*	10	1. Assess scenarios suitable for minimisation of divertor and main chamber erosion 2. Quantify and (try to) extrapolate main chamber filamentary transport , i.e. expected particle flux and energy 3. Understand mechanism forming the flat region known as ”density shoulder” in the far SOL	**Linked to TCV15-2.2-3**	H2.2_MST_D_4, H2.2_MST_D_6, H2.2_MST_D_13, H2.2_MST_D_16, H2.2_MST_D_18, H2.3_MST_D_1, H2.3_MST_D_2	
TCV15-He-13	SOL power width in limiter configuration in Helium *[Headline 2.2]*	20	1. Determine the nature of the short and long scale lengths of the heat flux in the SOL 2. Determine whether the two-length effect is present on the LFS as well or if it is only measurable on the HFS 3. Determine whether it is a universal feature of limited plasmas or not 4. Compare the results with nonlinear fluid simulations (GBS code) including shaping effects	**Linked to TCV15-2.2-4**	H2.2_MST_D_8	
TCV15-He-14	ECRH wall conditioning in Helium *[Headline 2.2]*	30	1. Document and optimize ECRH cleaning foreseen for JT-60SA on TCV 2. Specifically, assess the efficiency of ECRH cleaning for wall desaturation and/or recovery from disruption		H2.2_MST_He_4	
TCV15-He-15	Power width dependence on triangularity in Helium *[Headline 2.3]*	10	1. Measure power width with negative triangularity 2. Ideally scan from ‘normal’ to negative-triangularity shapes 3. Make use of inverse currents from shot to shot in TCV to change the drift direction w.r.t to helicity	**Linked with TCV15-2.3-2**	H2.3_MST_He_1	

III.3. How to apply for participation in Experiments

- **Apply though "Annex 5 - Form to propose participation in the MST1 programme"**
- **Note there are two worksheets in this file: "AUG proposed participation" for participation in MST1-AUG experimental campaign and "TCV proposed participation" for participation in MST1-TCV experimental campaign.**
- From the drop-down list in columns O, P, Q and R, enter the competencies applying the most to you (see Annex 4)
- From the drop-down list in columns AA, AB, AC, AD and AE, indicate experiments you would like to contribute to with these competencies.
- In column AK/AL describe the work you wish to perform for these experiments at the AUG/TCV site and back in your home institution
- In columns AM to AV for 2015 and in columns BC to BL for 2016, propose stays at the AUG / TCV site (matching the dates at which the experiment(s) you are interested in will be performed- see Annex 3)
    - When proposing participation in experiment(s), it is highly recommended that the proposed stay(s) on the AUG or TCV sites cover more than the single week when the experiment(s) is/are to be performed. This is particular true for scientific coordinators. The overall commitment to the programme needs to be high enough to allow a significant contribution.
    - To avoid formatting issues the dates to be entered are provided through a drop-down menu.
    - ENTER 1st DAY ON-SITE and LAST DAY ON-SITE (note that the date drop down menu does not allow arriving /leaving during week-end or on bank holidays). The PMU will estimate the travelling time associated taking into account the EUROfusion mission rules.
    - Stay can start 2 weeks ahead and end two weeks after the campaigns.
- In column AX for 2015 and in column BN for 2016, proposed analysis time back in your home institution entering WEEKS
- If you wish to be Scientic Coordinator: from the drop-down menu in column G to I, select the relevant experiment(s)