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Modelling needs in the 2020 MST1 programme

Presented by H. Meyer

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Points to be discussed

- **Brief overview of the MST1 2020 programme**
- **MST1 2020 users of WPCD tools and tasks to be addressed**
- **Urgent and long-term requests**

2020 MST1 Grant Agreement Deliverables

GD-MST1-3	Assessment of the **impact of the pedestal and SOL condition** in MST devices **for different methods achieving tolerable ELMs** on their scalability to larger devices	Dec.20
GD-MST1-4	Comparison of the **performance of specific alternative divertor configurations** with conventional divertors with respect to exhaust performance in steady state and during transients	Dec.20

2019-2020 MST1 Top Objectives

1. **Development of tolerable edge conditions for ITER and DEMO with respect to fast transients.**
   - active ELM control
   - natural high-confinement regimes with small- or no-ELMs and acceptable heat and particle loads on the wall structures

2. **Assessment of feasible divertor solutions with a strong emphasis on alternative divertor configurations.**
   - MAST-U and TCV are uniquely equipped with coil sets that allow the assessment of a large number of alternative divertor configurations
   - AUG will complement this area from 2023/23 onwards also allowing for studies at high power densities.

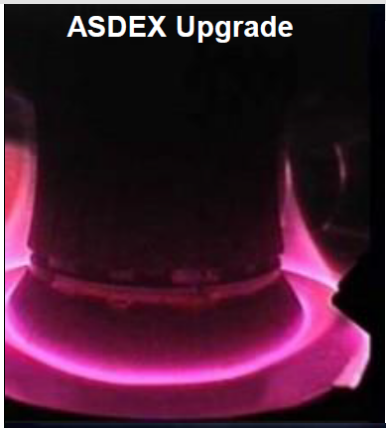
3. **Development of robust physics-based strategies for disruption and runaway electron beam handling.**
   - Flexible ECRH/ECCD systems available on AUG and TCV
   - 3D magnetic perturbations available on AUG and MAST-U

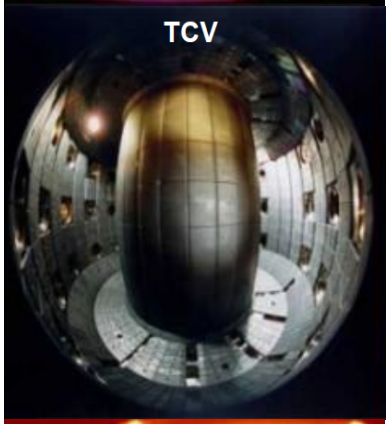
MST1 physics programme

➢ **Goal:** complement the work at JET and provide a step-ladder approach for extrapolations to ITER and DEMO and in areas where the MSTs have superior experimental capabilities and flexibility

➢ **MST1 programme structure: 17 High Level Topics covering**

- ❑ **Physics of core plasma, scenario development, exploration and optimisation**:
  - ✓ ITER H-mode scenario operating space
  - ✓ Optimisation of Advanced / Non-Inductive Scenarios
  - ✓ General scenario issues:
    - *Transport and control of W / heavy impurities in the core and SOL*
    - *Fast ion confinement, transport and control*
- ❑ **Disruption prediction mitigation and avoidance**
  - ✓ Plasma control, real time handling of off-normal events
  - ✓ Error field detection and control
- ❑ **Runaway electron beam physics**
  - ✓ Generation and control of RE beam
  - ✓ Mitigation of RE using MGI, SPI (AUG from 2021) and 3D perturbations.
- ❑ **Pedestal physics**:
  - ✓ Pedestal performance under ITER/DEMO relevant SOL conditions
  - ✓ ELM control and suppression (type I), small- and no-ELM regimes
- ❑ **SOL physics**:
  - ✓ Heat and particle loads, detachment and its control
  - ✓ Detachment in alternative divertor configurations in H- and L-mode
  - ✓ Effect of filamentary transport on heat and particle loads
- ❑ **Plasma-wall interaction**:
  - ✓ Plasma loading of tile gaps, misaligned components and damaged surfaces





Coordination of modelling support to MST1 experiments

- **Modelling is strongly linked to experiments, modellers are working within topical teams**
- **Modelling coordination in five areas:**
  - Energetic Particle Modelling (Modelling Coordinator Sergei Sharapov)
  - MHD modelling (Modelling Coordinator just resigned)
  - Pedestal and Edge modelling (Modelling Coordinator Hendrik Meyer)
  - Edge and SOL Modelling (Modelling Coordinator Marco Wischmeier)
  - Scenario and Core Transport Modelling (Modelling Coordinator Irina Voitsekhovitch)

MST1 users of WPCD tools in 2020 (total participation: 400 days~1.8 ppy)

Topic	Team	Tasks	Commitment
Core transport/scenario (T01, T10)	F. Eriksson, E, Fransson, P. Strand, M. Poradzinski, J. Ferreira	Modelling of main plasma species (ni, Ti, Te), validation of theory-based transport models, density peaking in AUG and TCV IBL	140 days
	I. Ivanova-Stanik, F. Jaulmes	Impurity modelling → AUG T01 and T10	85 days
NTM (T01, T13)	S. Nowak	Modelling of NTM triggering and evolution, NTM impact on plasma performance → TCV	40 days
Runaway Electrons (T08)	S. Olasz, G. Pokol	Data import to IMAS, RE simulation for AUG and TCV	75 days
Edge turbulence synth. diagnostics (T16)	A. Nielsen, O. Asztalos,	Testing data acquisition (BES and other relevant data) for use in turbulence WF developed in WPCD-WIMAS 3 (HESEL + RENATE BES synthetic diagnostic) → AUG, MAST-U	60 days

2019 joint MST1 – WPCD activities and coming events

- **MST1-WPCD training and modelling working session October 2019, IPP-Garching**
  - From training to modelling: work on T01 and T10 discharges
  - Participation of experienced ETS users and newcomers (F. Jaulmes, Y. Kazakov)
  - Excellent, well-organised support from the WPCD side → THANK YOU!

- **MST1 core transport and scenario modelling working session, November 2019, IPP-Garching**
  - participation and important contributions by MST1 ETS modellers

- **Coming events (under discussion):**
  - ETS modelling week, March-April 2020, IPP-Garching
  - Joint JET1 – MST1 – CD – SA modelling working session, JET, end-April 2020

Coming MST1 publications involving the modelling with WPCD tools

- **Emil Fransson, Frida Eriksson et al, "*Modelling particle transport of ITER baseline scenario plasmas at TCV and AUG using ETS and GENE*", IAEA FEC 2020**
- **Soma Olasz et al, "*Runaway electron modelling in the EU-IM framework*", EPS 2020**
- **Possible contribution with impurity modelling to the paper by Axel Jardin et al "*Investigations of the impact of heating schemes and poloidal asymmetries on the heavy impurity transport in AUG and TCV*", EPS 2020**

Review of 2019 short-term requests to WPCD

- **Tools for CPO preparation using AUG and TCV data:**
  - ➢ tools developed, tested and provided to users in time

- **User training and support, assistance with setting the ETS WF, discussion of simulation results**
  - ➢ Efficient training and support during the ETS training and modelling WS
  - ➢ Regular support outside working sessions is provided

Thank you!

New short term requests and fixes

- **Tools for the CPO preparation using users private data**
- **Time dependent ne+Te+Ti+j simulations**
- **Convective term in BgB model**
- **H&CD WF: dual frequency ICRF heating**
- **Use and capability of the Equilibrium chain**
  - Implementation of CLISTE in WPCD.

The use of IMAS would also allow machine independent analysis code development – Is there support for this?
Good prototype would be an MHD spectral analysis code.

Long term requests (inc. the previous list)

- **Models for pedestal transport and for estimation of pedestal height**
  - Need to include the fuelling as $n_{e,sep}$ is important (2D SOL + EUROPED)
- **Core-SOL integration**
- **Implementation of advanced divertor configurations**
- **Self-consistent fast ion WF: FI impact on thermal transport + FI-driven instabilities + FI losses**
  - Need to integrate MEGA (EU-Japan) as 3D physics is important for MST1 (and S1)
- **Full integration of non-linear 3D MHD code.**
- **…**

Need to advertise the code capabilities
(e.g. the Equilibrium chain is not yet as powerful as codes on individual devices).