

## Database for the TSVV code validation

### Proponent

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### Classification

<b>EUROfusion work package:</b>	WPW7X
<b>Topic(s):</b>	<ul style="list-style-type: none"> <li>• Exploration of reduced turbulence / high performance scenarios w.r.t. stationary plasma conditions, kinetic-, density-, and impurity-profile control</li> <li>• Exploration of heating scenarios using upgraded plasma heating capabilities (ECRH, NBI, ICRH)</li> <li>• Develop high beta plasma scenario by means of low field operation</li> <li>• Integrated scenarios for long-pulse operation with PFC heat load control, efficient particle exhaust, and impurity screening</li> <li>• Development of long, stationary divertor detachment scenarios with and without impurity seeding</li> <li>• Reference discharge</li> <li>• Complete the core transport and stability physics basis in the extended operational space</li> <li>• Exploitation of low-field high-beta scenarios to demonstrate W7-X optimization</li> </ul>
<b>Deliverable(s):</b>	<ul style="list-style-type: none"> <li>• Assessment of W7-X MHD optimization criteria at increased plasma beta and extended magnetic configuration space.</li> <li>• Assessment of capabilities for the demonstration of improved fast ion confinement of W7-X at high beta</li> <li>• Assessment of density profile control</li> <li>• Assessment of the effects of heating and fueling actuators (profile shaping, fast ions) and magnetic configuration on turbulent transport.</li> <li>• Characterize the conditions under which detachment is possible</li> <li>• Confirmation of neoclassical optimization at increased ion temperatures.</li> <li>• Confirmation of reduced equilibrium currents at higher betas and different magnetic configurations.</li> <li>• Demonstrate effective ion heating</li> <li>• Demonstration of long-pulse operation (1 GJ energy turnaround)</li> <li>• Develop capability to extrapolate B-field dependency to high-field reactor operation</li> <li>• Documentation of core impurity profiles and perturbative experiments for detailed impurity transport analysis and modelling.</li> <li>• Documentation of high-beta plasma profiles for detailed transport analysis and modelling, w/ emphasis on magnetic fluctuation measurements.</li> </ul>

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- Documentation of relevant plasma profiles for detailed transport analysis and modelling.
- Exhaustive operational map of the W7-X configuration space including operation limits
- High plasma performance in the order of seconds, including
  - $T_i$  above clamping limit (1.5 keV)
  - $E$  equal or better to ISS04 scaling
- Regular performance of a standardized discharge with defined diagnostic coverage throughout campaign
- Validation of fast ion loss simulation tools

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## Physics Description

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### Scientific background and objectives

This comprehensive proposal is to ensure a coverage of accessible density and accessible power scans in different magnetic configurations at accessible field strengths (and directions), to deliver a good profile documentation of experimental data needed for the validation of codes developed in the EUROfusion TSVV 12 and TSVV13 activities and to assess their predictive power. The proposal aims at a systematic documentation of operation ranges, the energy and particle confinement times, anomalous transport coefficients, stiffness, bootstrap currents, L/R times, resistive times pulse lengths, triple product and other performance figures.

The proposal is valid throughout the campaign, will continuously monitor (in piggy-back) experiments and becomes active to complete scans for the purpose of documentation. During the campaign a completion of the documentation is foreseen and co-factors (detachment,  $P_e/P_i$ , X2/X3/O2 heating, heating mix w/ NBI, operation time since wall conditioning) will be included. A comprehensive description of the documentation is found at <https://indico.eurofusion.org/event/2058/contributions/7488/attachments/3191/5794/description.pdf> (description of the International Stellarator/Heliotron Confinement Database (v27)).

This proposal will provide input for deliverables of the EUROfusion Workpackage WPW7X and TSVV tasks. The proposal will also contribute to multi-machine comparisons envisaged within the IEA Stellarator-Heliotron TCP.

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### Relevance to W7-X program

The proposal ensures the completeness of the physics basis of the HELIAS line. It will complete and expand the operation maps derived for OP1.

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### Approach and Methodology

- n, P scans (like min density ... max density, min heating power ... max heating power)
  - configuration changes
- Dedicated programs:
- complete the documentation beyond parameters covered by other proposals (piggy-back)

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## Experiment configuration

<b>special diagnostics requirements:</b>	
<b>magnetic field</b> main magnetic field configuration:	EJM000+2519 (released)
comment:	
Beyond error field correction trim coil operation: control coil operation :	no preference no preference
<b>plasma density</b> plasma density range [m <sup>-3</sup> ]: divertor state:	min:                      max: no preference
<b>gases and fueling</b> gas fueling: gas fueling system: pellet fueling: seeding: diagnostic use:	no preference preference no preference no preference no preference
<b>plasma heating</b> ECRH heating: ECRH off-axis heating: ECRH current drive:	no preference    min [MW] :                      max [MW] : no preference no preference
NBI NBI diagnostics blibs allowed :	no preference    min [MW] :                      max [MW] : no preference
ICRH :	no preference
Number of dedicated programs: Number of preparatory programs :	0

Remarks:

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