

**Plasma-Wall Interaction and Exhaust Work Package Execution Plan (PEP)**

DOCUMENT APPROVAL RECORD

|  |  |  |
| --- | --- | --- |
| Name | Role | Signature |
| Sebastijan Brezinsek | Author | See IDM |
| Carme de Andres | Reviewer | See IDM |
| David Douai | Reviewer | See IDM |
| Volker Naulin | Reviewer | See IDM |
| Project Board Chair | Approver | See IDM |

|  |  |
| --- | --- |
| IDM ref. | xxxxxx |
| Version | 1.0 (consistent with IDM) |
| Date of Issue | 07/06/2021 |

CHANGE LOG

|  |  |  |
| --- | --- | --- |
| Reason for and (short) description of change(s) | Version | Date |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

Table of Contents

[1 WORK PACKAGE DESCRIPTION 5](#_Toc72223036)

[1.1 Scope description 5](#_Toc72223037)

[1.2 Interfaces to other WP 6](#_Toc72223038)

[2 WORK BREAKDOWN STRUCTURE 7](#_Toc72223039)

[3 PLANNING and SCHEDULE 9](#_Toc72223040)

[3.1 Time schedule (Gantt chart) 9](#_Toc72223041)

[3.2 List of Milestones 10](#_Toc72223042)

[3.3 List of Deliverables 12](#_Toc72223043)

[4 ROLES AND RESPONSIBILITIES 20](#_Toc72223044)

[4.1 WP Team Organisation 21](#_Toc72223045)

[4.2 WP Team Directory – Contact Details 22](#_Toc72223046)

[5 RISK IDENTIFICATION 24](#_Toc72223047)

[6 RESOURCES 26](#_Toc72223048)

[6.1 Budget 26](#_Toc72223049)

[6.2 Human Resources Breakdown for 2021 (Manpower broken down by WP Deliverables) 31](#_Toc72223050)

[6.3 Equipment and Other Goods and Services 32](#_Toc72223051)

[6.4 Use of Facilities 32](#_Toc72223052)

[6.5 Facility Investment, i.e. new build or upgrade 35](#_Toc72223053)

[6.6 International Collaboration 35](#_Toc72223054)

[7 REFERENCED DOCUMENTS 36](#_Toc72223055)

[7.1 ANNEX 1: WPPWIE 2021 Activity Descriptions 37](#_Toc72223056)

[7.2 ANNEX 2: WPPWIE 2021 facility resources summary 94](#_Toc72223057)

Abbreviations (TBC)

|  |  |
| --- | --- |
| **Acronym** | **Definition** |
| WBS | Work Breakdown Structure |
| PM | Project Management |
| QA | Quality Assurance |
| AWP | Annual Work Plan |
| WP | Work Package |
| … | … |

# WORK PACKAGE DESCRIPTION

## Scope description

WPPWIE is a key Work Package mainly under Mission 2 for the development and implementation of EUROfusion’s strategy on plasma-facing materials (PFM) compatible exhaust solutions and plasma-wall interactions (PWI) induced limitations regarding lifetime and safety. WPPWIE deals with conventional metallic PFMs, as used in ITER (Beryllium and Tungsten) as well as advanced materials for both the divertor (e.g. fibre-reinforced tungsten) and the main chamber (e.g. EUROFER or advanced steels), which are currently explored for the later use in DEMO.

Plasma EXhaust (PEX) is a key design element for next generation devices, as increasing fusion output comes at the cost of a more challenging handling of the residual power that needs finally to be dissipated at the plasma-facing components (PFCs). The limitations of PFM, challenged by the neutron-rich environment in a reactor, pose stringent constraints on exhaust solutions, as the predicted unmitigated loads for DEMO, i.e. the loads that would occur without specific measures to reduce them, might be beyond tolerable values. To extrapolate present day results to ITER, DEMO, and HELIAS with sufficient confidence, adequate predictive capability will be obtained through development of models/advanced simulations for the plasma edge (incl. TSVV #3-5), the plasma-material interactions (incl. TSVV #6-7), and for materials. These models/simulations complement experimental observations, which lead to improved empirical trends and scaling laws. Development of theories and systematic simulation studies are carried out within WP PWIE as well as the compilation and critical assessments of cross-machine experimental results. This includes exploration of a limited number of advanced divertor configuration (ADC) solutions for DEMO and the assessment of its realisation in the Divertor Test Tokamak (DTT).

The focus of PWI activities lays in studies with ITER (W, Be) and DEMO-relevant PFMs (W) , the plasma fuel species (H, D, T), the fusion ash (He), a portfolio of seeding species (N2, Ne, Ar, Kr, etc.), and intrinsic impurities as present in nowadays devices (C, O, Fe, Cr, Ni, etc.). The impact of neutrons on PWI processes like W erosion or T retention is studied by proxy damaging processes and validated against fission neutron damage in the upcoming PEXfacility JULE-PSI.

WP PWIE covers experiments in linear plasma devices like MAGNUM-PSI and PSI-2, high heat flux facilities like JUDITH and GLADIS, and laboratory experiments providing essential information about the underlying PWI physics and boundary conditions for the predictions, and thus, for the safe and reliable operation in the next-step devices. Moreover, WPPWIE includes modelling spanning a full range from the atomistic level (e.g. DFT and MD) to the global migration in tokamaks (e.g. ERO and WallDYN) in order to prepare the predictive tools for ITER and DEMO.

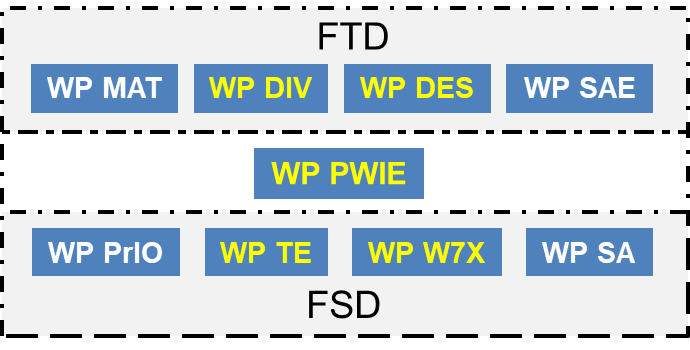
Dedicated PWIE experiments in present day toroidal devices like ASDEX Upgrade, W7-X, etc. are carried out in connection with WPTE and WPW7X utilising divertor/midplane manipulators supporting the transfer of W7-X as well as JT60-SA to a full metallic device.

WPPWIE also investigates the PWI at the full W tokamak WEST with the main focus in the characterisation, exploitation, and qualification of the actively cooled ITER- and DEMO-like plasma-facing units in a toroidal environment at high magnetic field and particle fluence and with complex shaping geometries. These studies are compared with high fluence experiments in MAGNUM-PSI executed in the view of urgent ITER and DEMO needs as well as used in modelling verification in order to allow extrapolations.

## Interfaces to other WP

WPPWIE is part of the FSD and works hand in hand with WPs related to toroidal facilities: WPTE, WPW7X, and WPJET. WPPWIE executes a part of the post-mortem analysis of these facilities to study global PWI and models is interpretative. Moreover, WPPWIE executes dedicated experiments jointly with these facilities utilising e.g. pre-damaged PFCs, manipulators etc. including pre-characterisation, post-analysis, and modelling.

WPPWI supports ITER together with WPPrIO with joint projects including diagnostics.

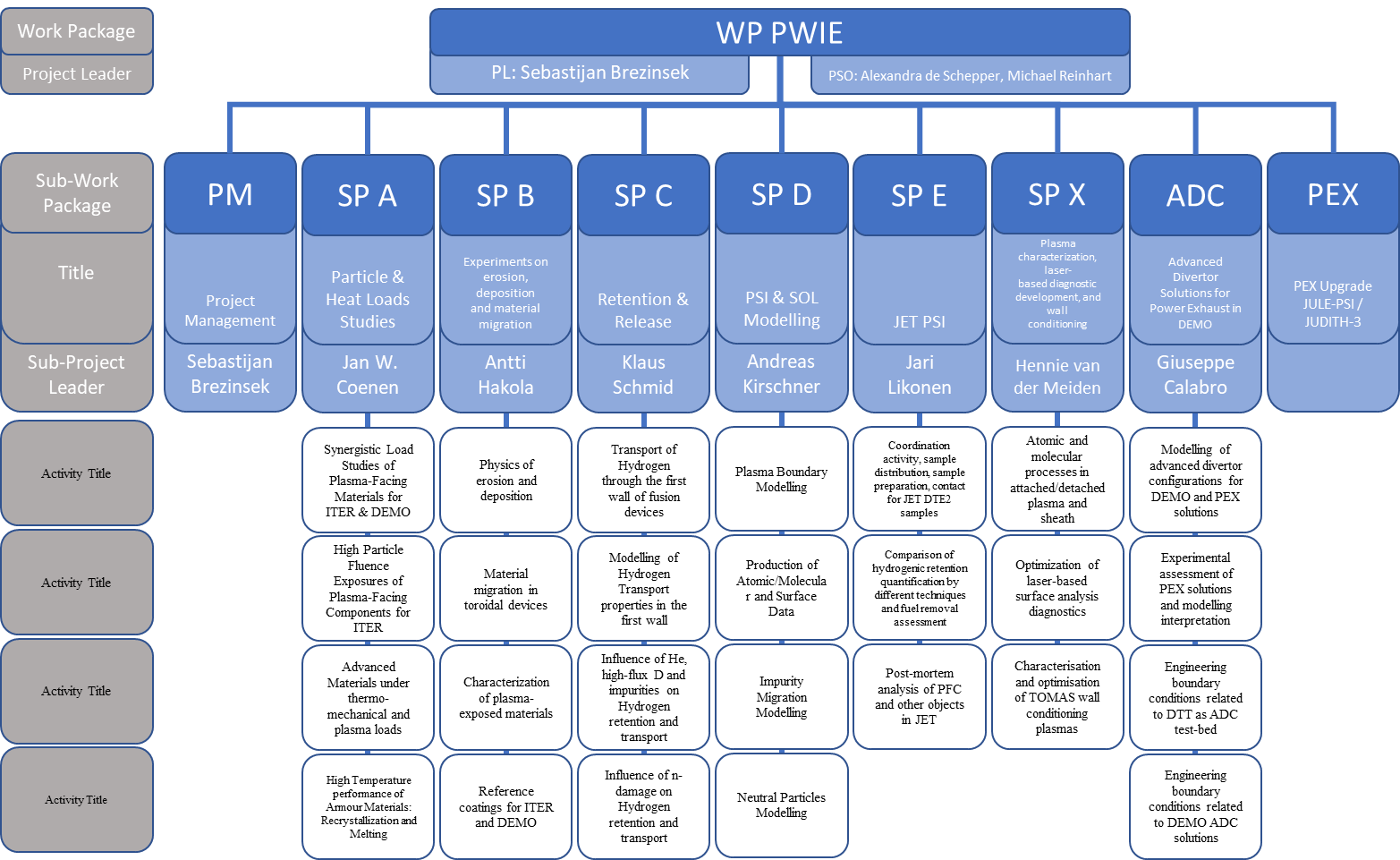


WPPWIE works jointly together with WPDES and DCT in the FTD regarding the definition and predictive modelling of the ADC.

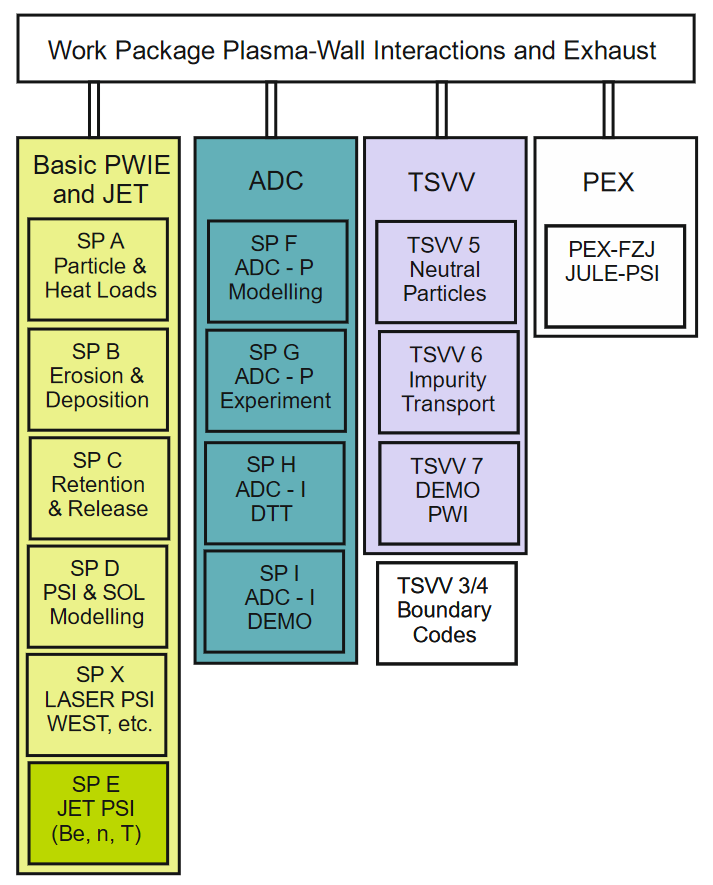
WPPWIE supports also the transformation of W7X and JT60SA towards a full-W device by supporting e.g. qualification of PFCs under plasma and heat load. WPWIE supports also the predictive modelling for the selection of the DTT divertor including qualification of PFCs. These work is hand in hand with WP DIV which designs and develops the PFCs as well as performs the material qualification.

WPPWIE works with WPMAT regarding DEMO material qualification including neutron damaged materials. WPWIE also supports adavanced materials covered under WPPRD.

# WORK BREAKDOWN STRUCTURE



**Figure 1: WP Organisational Chart**



**Figure 2: WP Organisational Chart**

Figure 1 shows the WBS of WP PWIE for 2021, not including the individual level-3 deliverables in the activities (see ANNEX 1).

Figure 2 shows the simplified WBS of WP PWIE for 2021 with link of the TSVVs attributed to WPPWIE. WPPWIE consists of four coordination areas: PWI, ADC, TSVV, and PEX, which include ten sub-projects (SP), three associated TSVVs, and one PEX upgrade task.

# PLANNING and SCHEDULE

## Time schedule (Gantt chart)



Figure 3: Gantt Chart for WPPWIE, Milestones (M05) and Deliverables (D05) listed in section 3.2 and 3.3

## List of Milestones

Two types of milestones need to be distinguished:

* Grant Agreement Milestones (🡪 Table 1)
* Work Package Milestones (🡪 Table 2)

Table : Grant Agreement Milestones

|  |  |  |
| --- | --- | --- |
| **SyGMa ID** | Title | Due Date |
| M05.01 | Initial tile analysis of WEST PFUs and W7-X TDU PFCs completed | 31.12.2021 |
| M05.02 | Comparative modelling of first set of revised advanced divertor solutions executed. | 31.12.2021 |
| M05.03 | Modelling of fuel retention in W under combined D+He exposure and self-damaged W by diffusion and trapping executed. | 31.12.2021 |
| M05.04 | High fluence experiments in deuterium (L-mode) discharges on ITER-like PFUs in WEST executed. | 30.06.2022 |
| M05.05 | Incorporation of turbulence in multi-fluid calculations using physics-based diffusion coefficients (with TSVVs). | 30.06.2022 |
| M05.06 | Comparative experiments of different LASER-based techniques on W and other reference samples executed. | 31.12.2022 |
| M05.07 | Interpretative modelling of W migration and D retention in WEST high fluence discharges completed. | 31.12.2022 |
| M05.08 | Exposition of initial set of reference and advanced W materials for DEMO and JT-60SA in HHF and plasma devices executed. | 31.12.2023 |
| M05.09 | 3D Modelling of first wall erosion and fuel retention in the DEMO-1 reference scenario completed (TSVV). | 31.12.2023 |
| M05.10 | Initial neutral particle code development done and interface to plasma boundary code coupling specified (TSVV). | 31.12.2023 |
| M05.11 | FZJ PEX facility with JULE-PSI and JUDITH-3 is fully operational and ready for scientific exploitation. | 31.12.2024 |
| M05.12 | Exposition of initial set of reference and advanced W PFCs for DEMO and JT-60SA to fluence up to 1030m-2 in MAGNUM-PSI and UPP executed. | 31.12.2024 |
| M05.13 | Helium plasmas and fuel/He recovery experiments in WEST executed and samples removed. | 31.12.2024 |
| M05.14 | Potential PFCs solutions for an all-W W7-X identified and reference samples exposed in HHF and plasma devices to stellarator relevant power loads and fluence. | 31.12.2025 |
| M05.15 | Exposition of neutron-damaged and self-damaged W samples in JULE-PSI. | 31.12.2025 |

Table : Work Package Milestones

|  |  |  |
| --- | --- | --- |
| **ID** | Title | Due Date |
| WM01 | Development analysis methods to determine of underlying mechanisms for recrystallization which impacts the lifetime of tungsten-based PFCs from e.g. WPMAT (ITER+DEMO) | 31.12.2021 |
| WM02 | Assessment of W-heavy alloy PFCs for use in current and future fusion devices with a focus on high heat flux treatment and high fluence plasma exposure (DEMO+ITER) | 31.12.2021 |
| WM03 | Exposure of DEMO baseline divertor PFC mono-blocks (from WPDIV) in MAGNUM-PSI in D and D+Ne conditions to high fluence (DEMO) | 31.12.2021 |
| WM04 | Experimental determination of effective tungsten sputtering yields on different types of rough surfaces in pure and mixed plasmas and comparison with laboratory experiments (ITER+DEMO) | 31.12.2021 |
| WM05 | Provision of the gross and net erosion balance of W PFCs in L. and H-mode plasmas in tokamaks with the aid of marker probes (ITER) | 31.12.2021 |
| WM06 | Completion of W marker tiles surface analysis exposed in the deuterium campaign C3. First assessment of the erosion/deposition on W PFUs in WEST after the He campaign C4 (ITER+DEMO) | 31.12.2021 |
| WM07 | Documentation of the impact of oxygen layers on the uptake and release of hydrogen from W (ITER+DEMO) | 31.12.2021 |
| WM08 | Assessment of the role of W layers on the hydrogen isotope permeation through steels (DEMO) | 31.12.2021 |
| WM09 | Determination of the H permeation through ITER W PFC to the underlying Cu heatsink (ITER) | 31.12.2021 |
| WM10 | Provision of plasma backgrounds for a set of JET-ILW H-mode D plasmas (EDGE2D-EIRENE), WEST He plasmas (SOLEDGE-EIRENE), and W7-X H plasmas (EMC3-EIRENE) used for interpret-tative impurity migration modelling (ITER) | 31.12.2021 |
| WM11 | Provision of atomic, molecular and surface data necessary to model impurity migration. Main focus is on ionisation, excitation, reflection and sputtering data for W materials including morphology effects and crystal orientation (DEMO+ITER) | 31.12.2021 |
| WM12 | Benchmark the quantify the predictive modelling capabilities of erosion sources, impurity migration and resulting deposition in JET, WEST, W7-X, and ITER (ERO, WallDYN) (ITER) | 31.12.2021 |
| WM13 | Realization of diagnostics for determination of ro-vibrational distribution of the ground state of H2 and D2 and atomic densities in PSI-2 and MAGNUM-PSI to provide access to neutral particle properties under ITER and DEMO conditions (ITER+DEMO) | 31.12.2021 |
| WM14 | Determination of the role of material composition and surface roughness on the laser-induced ablation rate and its conversion into depth-resolved information about material composition and fuel content in ITER-like materials and surface layers or co-deposits (ITER) | 31.12.2021 |
| WM15 | Quantification of the energetic neutral contribution in Ion and Electron Cyclotron Wall Conditioning in TOMAS and qualification of its impact on fuel removal from W7-X PFCs (DEMO+ITER) | 31.12.2021 |
| WM16 | Improvement of detached regimes in ADCs, including the effects of kinetic neutrals and sensitivity studies for the most uncertain input parameters regarding e.g. plasma transport (DEMO+ITER) | 31.12.2021 |
| WM17 | Development of a reduced model from ADC experiments/simulations to scaling laws applicable for DEMO size and comparison with scaling laws extracted from existing DEMO scale simulations (DEMO) | 31.12.2021 |
| WM18 | Engineering compatibility assessment of potential best promising DEMO ADC solutions with the DTT facility (DEMO) | 31.12.2021 |
| WM19 | Engineering DEMO evaluation of most favourable ADC solutions in terms of VDE and disruption events compatibility (DEMO) | 31.12.2021 |
| WM20 | Portfolio selection of key application (validation, verification, realistic scale) cases and set-up of most of them including full-scale ITER and DEMO cases with the aim to demonstrate the advantages of the restructuring into the Neutral Gas Model (NGM) and improved EIRENE | 31.12.2021 |
| WM21 | Start with modulation of EIRENE by segregating the numeric core, incorporate ADAS “MDF” formats allowing refinement of CRMs, and reactivate time-dependent simulations (ITER+DEMO | 31.12.2021 |
| WM22 | First test run of SOLEDGE-EIRENE with a 3D wall in a WEST geometry (ITER) | 31.12.2021 |
| WM23 | Implementation of EIRENE Kinetic Ion Trace module in EMC3-EIRENE for low Z impurities (ITER+DEMO) | 31.12.2021 |
| WM24 | Adaption of available ITER plasma backgrounds to DEMO. First scoping PIC, dust transport and ERO2.0 simulations with these backgrounds (ITER + DEMO) | 31.12.2021 |
| WM25 | Implementation and validation of thermo-migration and material interface models in hydrogen retention codes (TESSIM-X and FESTIM) with identified common test cases (DEMO) | 31.12.2021 |

## List of Deliverables

Two types of deliverables need to be distinguished:

* Grant Agreement Deliverables (🡪 Table 3)
* Work Package Deliverables (🡪 Table 4)

*Grant Agreement deliverables* are the contractual deliverables between the EUROfusion consortium and the European Commission, therefore listed in the Grant Agreement.

Table 3: Grant Agreement Deliverables

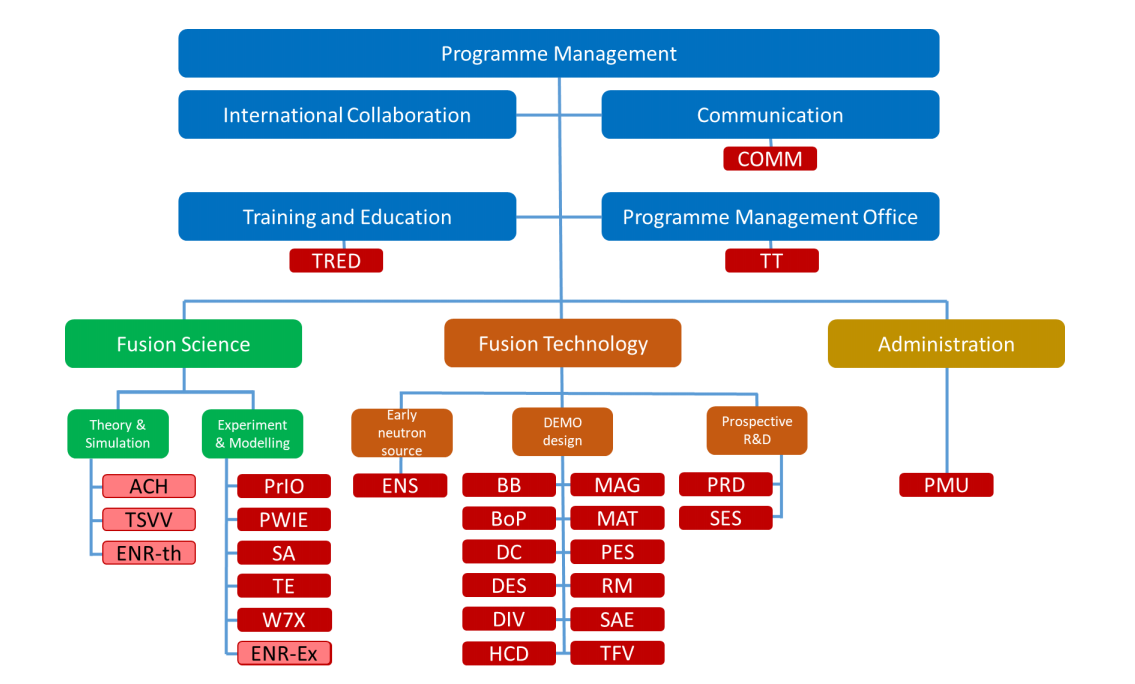
|  |  |  |
| --- | --- | --- |
| **SyGMa ID** | Title | Due Date |
| D05.01 | Post-mortem analysis of plasma-facing components exposed in W7-X (graphite) and WEST (ITER-like tungsten PFUs) in FP8. Reports on campaign integrated material migration pattern and modelling in both devices. | 31.12.2021 |
| D05.02 | Diffusion and trapping modelling in W PFCs under combined D+He impact and ion-induced self-damage for ITER / DEMO-like conditions. Report on underlying physics and fuel recovery strategies. | 31.12.2021 |
| D05.03 | Optimization of laser-based diagnostics for ITER and other long-pulse devices regarding material composition and fuel retention quantification. Selection of most suitable approaches [report]. | 31.12.2022 |
| D05.04 | Interpretative PSI modelling of material migration and fuel retention in WEST, JET, ASDEX Upgrade and initial predictive PSI modelling for W7-X with full-W PFCs [report]. | 31.12.2022 |
| D05.05 | Initial assessment on the impact of material damage (pre-irradiation) on fuel retention in W [report]. | 31.12.2022 |
| D05.06 | Damage matrix from the exposition of advanced W materials in HHF and plasma devices [report]. | 31.12.2023 |
| D05.07 | PSI modelling of DEMO main chamber erosion, deposition and fuel retention. PIC modelling of the sheath in the DEMO divertor (with TSVV-7) | 31.12.2023 |
| D05.08 | Neutral gas kinetics modular code upgraded and midterm verification/validation (with TSVV). | 31.12.2023 |
| D05.09 | Initial PSI modelling of W sources, screening, transport and core concentration in full W-devices | 31.12.2023 |
| D05.10 | Recommendation to ITER-IO on Material Research Laboratory on the ITER site regarding T, Be and neutron-activated materials: minimum requirement and auxiliary systems | 31.12.2023 |
| D05.11 | Comprehensive catalogue on dust in metal devices: generation, migration, quantity, impact of moisture on dust generation | 31.12.2023 |
| D05.12 | In-situ fuel inventory assessment with the use of laser induced desorption techniques to monitor T retention in JET. | 31.12.2023 |
| D05.13 | Report on the demonstration of LIBS as T detection technique in JET using remote handling. | 31.12.2024 |
| D05.14 | Properties of JET bulk tungsten and beryllium after extensive test under reactor conditions | 31.12.2024 |
| D05.15 | Initial exploration of HML (PEX Upgrade) capabilities regarding JUDITH-3 and JULE-PSI usage | 31.12.2024 |
| D05.16 | Exploitation of experiments (WEST, JET, ASDEX Upgrade) related to material migration, fuel retention, and fuel recovery including interpretative plasma-edge and PWI modelling | 31.12.2024 |
| D05.17 | Assessment of LID-QMS as in-situ fuel retention technique in JET and extrapolate to ITER conditions. | 31.12.2024 |
| D05.18 | Simulation of JET and PEX Upgrades results in view of ITER divertor and DEMO/DTT alternative configurations. Quantitative comparison of potential benefits alternative configurations with respect to conventional solutions in view of exhaust performances and core compatibility (input to overarching PEX.M1 milestone). | 31.12.2024 |
| D05.19 | Characterization and predictive modelling of plasma-wall interactions in He und He/H mixed plasmas for ITER in Pre-Fusion Power phase | 31.12.2025 |
| D05.20 | High fluence exposition of mono blocks made of references W and advanced W materials for DEMO, JT60-SA, DTT in MAGNUM-PSI and UPP including pre- and post-characterisation | 31.12.2025 |
| D05.21 | Fuel retention studies in self-damaged and neutron damaged materials exposed in JULE-PSI | 31.12.2025 |
| D05.22 | Comparison of in-situ (LID-QMS in JET) and ex-situ examination (FREDIS, TDS) of the laser-irradiated components regarding fuel/tritium content | 31.12.2025 |
| D05.23 | PSI modelling of DEMO main chamber erosion, deposition and fuel retention. PIC modelling of the sheath in the DEMO divertor (with TSVV) | 31.12.2025 |
| D05.24 | Neutral gas kinetics modular code upgraded and final verification/validation report (with TSVV). | 31.12.2025 |
| D05.25 | Initial PSI modelling of W sources, screening, transport and core concentration in full W-devices (with TSVV) | 31.12.2025 |

*Work Package (WP) deliverables* (Table 4) are the deliverables on the level of the Work Packages that lead to the accomplishment of the Grant Agreement deliverables, as listed in Table 3.

Table 4: WP deliverables for 2021 (corresponding to Annual Work Plan 2021)

|  |  |  |
| --- | --- | --- |
| **IMS ID** | Title | Due Date |
| PWIE-SP A.1.T-T001-D001 | Damage threshold for different W materials at varying loading conditions in matrix form & Understanding the damage mechanisms and changes in material properties, influence of / changes in the retention behavior (FZJ) | 31.12.2021 |
| PWIE-SP A.1.T-T001-D002 | Pre-crack damage evolution and erosion under transient loading (DIFFER) | 31.12.2021 |
| PWIE-SP A.1.T-T001-D003 | Qualification of OLMAT as HHF facility in comparison with QSPA and GLADIS (CIEMAT) | 31.12.2021 |
| PWIE-SP A.1.T-T001-D004 | Qualification of W-Heavy Alloys for use in W7-X in conjunction with test on new tungsten mock-ups (WP MAT) and PFUs for WEST (WP TE) (MPG) | 31.12.2021 |
| PWIE-SP A.1.T-T001-D005 | Qualification of current baseline materials under transient (HHF plasma load with QSPA) and steady state loading (PSI-2, JUDITH) (KIPT) | 31.12.2021 |
| PWIE-SP A.2.T-T001-D001 | Influence of plasma on Rx under slow transient loading (DIFFER) | 31.12.2021 |
| PWIE-SP A.2.T-T001-D002 | Pre- and post characterization of samples (MPG) | 31.12.2021 |
| PWIE-SP A.3.T-T001-D001 | Analysis of Material behavior e.g. (Wf/W) under Plasma and heat loading regarding mechanical properties e.g. cracking, embrittlement, and microstructure. Link to SP A4 (FZJ) | 31.12.2021 |
| PWIE-SP A.3.T-T001-D002 | Performance of advanced materials under high heat loads and their microstructural characterization (MPG) | 31.12.2021 |
| PWIE-SP A.3.T-T001-D003 | Results from tests of small-scale samples of W and other advanced materials and components (LPP-ERM/KMS) | 31.12.2021 |
| PWIE-SP A.3.T-T001-D004 | Investigation of advanced materials under ELM-like/disruption transient loading and subsequent analysis (KIPT) | 31.12.2021 |
| PWIE-SP A.3.T-T001-D005 | Exposure of advanced materials in Magnum-PSI and subsequent analysis including thermal shock response of CVD-W to pulsed plasma (DIFFER) | 31.12.2021 |
| PWIE-SP A.3.T-T001-D006 | Effect of energetic ion irradiation on the strength of W wire (MPG) | 31.12.2021 |
| PWIE-SP A.4.T-T001-D001 | Assessment of hydrogen impact on material properties linked to ITER relevant PFUs (CEA) | 31.12.2021 |
| PWIE-SP A.4.T-T001-D003 | Development and validation of the MEMOS-U code (link with WP TE – WEST/AUG) (VR) | 31.12.2021 |
| PWIE-SP A.4.T-T001-D004 | Code Development examine specific engineering use cases for transient heat flux analysis on ITER and/or DEMO (JSI) | 31.12.2021 |
| PWIE-SP A.4.T-T001-D005 | Influence of plasma pre irradiation with heat loads near surface recrystallization on surface damaging with heat loads above the melting threshold (KIPT) | 31.12.2021 |
| PWIE-SP A.4.T-T001-D006 | Analysis for PSI-2 exposed materials, focusing on recrystallization (FZJ) | 31.12.2021 |
| PWIE-SP B.1.T-T001-D001 | Erosion rates of W model systems and composition and structure of re-deposited layers in MAGNUM-PSI at varying plasma conditions (DIFFER) | 31.12.2021 |
| PWIE-SP B.1.T-T001-D002 | Effective sputtering yields of W model systems with varying morphologies in pure and mixed plasmas in GyM and by hypervelocity dust impacts (ENEA) | 31.12.2021 |
| PWIE-SP B.1.T-T001-D003 | Erosion rates of W model systems with varying morphologies as well as composition and structure of re-deposited layers in PSI-2 at varying plasma conditions (FZJ) | 31.12.2021 |
| PWIE-SP B.1.T-T001-D004 | Effective sputtering yields of W model systems, including angular distributions of sputtered particles, and re-deposited W layers following exposure to controlled D and impurity ion beams (ÖAW) | 31.12.2021 |
| PWIE-SP B.1.T-T001-D005 | Size distribution and composition of Be and W dust formed during air and water leaks (IAP) | 31.12.2021 |
| PWIE-SP B.1.T-T001-D006 | RBS, ERDA and MEIS/LEIS characterization of selected samples from laboratory erosion and dust experiments (VR) | 31.12.2021 |
| PWIE-SP B.2.T-T001-D001 | Erosion, re-deposition, and fuel-retention patterns on selected WEST PFUs after C3, C4, and C5 campaigns (CEA) | 31.12.2021 |
| PWIE-SP B.2.T-T001-D002 | Erosion and re-deposition rates as a function of surface roughness/morphology changes in controlled L- and H-mode plasma experiments (JSI) | 31.12.2021 |
| PWIE-SP B.2.T-T001-D003 | Balance between gross and net erosion of plasma-facing materials in controlled L- and H-mode plasma experiments (VTT) | 31.12.2021 |
| PWIE-SP B.2.T-T001-D004 | NRA, SEM, and FIB characterization of marker samples and coatings from selected plasma experiments on AUG, WEST, and W7-X with conclusions (FZJ) | 31.12.2021 |
| PWIE-SP B.2.T-T001-D005 | RBS, NRA, SEM, and CLSM characterization of marker samples and coatings from selected plasma experiments on AUG with conclusions (MPG) | 31.12.2021 |
| PWIE-SP B.2.T-T001-D006 | RBS, NRA, SEM, and CLSM characterization of marker samples and coatings from selected plasma experiments on W7-X with conclusions (MPG) | 31.12.2021 |
| PWIE-SP B.2.T-T001-D007 | RBS, NRA, SEM, and CLSM characterization of marker samples and coatings from selected plasma experiments on WEST with conclusions (MPG) | 31.12.2021 |
| PWIE-SP B.2.T-T001-D008 | RBS, NRA, ERDA, and MEIS/LEIS characterization of marker samples and coatings from selected plasma experiments on AUG, WEST, and W7-X with conclusions (VR) |  |
| PWIE-SP B.2.T-T001-D009 | SEM, TEM and FIB characterization of selected samples from experiments on AUG, WEST, and W7-X (IPP\_LM) |  |
| PWIE-SP B.2.T-T001-D010 | ERDA, RBS, NRA and PIXE characterization of selected samples from experiments on AUG, WEST, and W7-X as well from laboratory and linear plasma experiments (RBI) | 31.12.2021 |
| PWIE-SP B.3.T-T001-D001 | Database on ageing, erosion, and fuel-retention behavior of selected WEST PFUs (CEA) | 31.12.2021 |
| PWIE-SP B.3.T-T001-D002 | SEM, FIB, NRA, and LIBS characterization of selected WEST and W7-X wall tiles and plasma-exposed reference samples (FZJ) | 31.12.2021 |
| PWIE-SP B.3.T-T001-D003 | SEM, TEM and FIB characterization of selected WEST PFUs and plasma-exposed reference samples (IPP\_LM) | 31.12.2021 |
| PWIE-SP B.3.T-T001-D004 | RBS and NRA characterization of selected WEST PFUs and plasma-exposed reference samples (IST) | 31.12.2021 |
| PWIE-SP B.3.T-T001-D005 | Surface analyses of selected AUG and WEST wall tiles (JSI) | 31.12.2021 |
| PWIE-SP B.3.T-T001-D006 | RBS, NRA, SEM, and CLSM characterization of selected AUG, WEST, and W7-X wall tiles and components as well as samples from MAGNUM-PSI (MPG) | 31.12.2021 |
| PWIE-SP B.3.T-T001-D007 | RBS, SEM, XPS, XRD and XRF characterization of selected Be reference coatings and plasma-exposed samples (NCSRD) | 31.12.2021 |
| PWIE-SP B.3.T-T001-D008 | RBS, NRA, ERDA, LIBS, and SIMS characterization of selected AUG, WEST and W7-X wall tiles and plasma-exposed reference samples (VTT) | 31.12.2021 |
| PWIE-SP B.4.T-T001-D001 | W-based coatings with pre-defined properties (incl. SEM, AFM, TDS characterization) produced for analyses and plasma experiments (ENEA) | 31.12.2021 |
| PWIE-SP B.4.T-T001-D002 | Be and W-based coatings with pre-defined properties (incl. SEM, XRD, GDOES, TDS characterization) produced for analyses and plasma experiments (IAP) | 31.12.2021 |
| PWIE-SP B.4.T-T001-D003 | Raman, SEM, and CLSM characterization of selected Be and W reference samples (CEA) | 31.12.2021 |
| PWIE-SP B.4.T-T001-D004 | SEM and SIMS characterization of selected W reference samples (CIEMAT) | 31.12.2021 |
| PWIE-SP B.4.T-T001-D005 | RBS and NRA characterization of selected Be and W reference samples (IST) | 31.12.2021 |
| PWIE-SP B.4.T-T001-D006 | TDS, XPS, and XRD characterization of selected Be and W reference samples (JSI) | 31.12.2021 |
| PWIE-SP B.4.T-T001-D007 | ERDA and PIXE characterization of selected Be and W reference samples (RBI) | 31.12.2021 |
| PWIE-SP B.4.T-T001-D008 | RBS, NRA, ERDA, LIBS, and SIMS characterization of selected Be and W reference samples (VTT) | 31.12.2021 |
| PWIE-SP C.1.T-T001-D001 | CEA: Uptake of D as function of O layer thickness in bulk and surface | 31.12.2021 |
| PWIE-SP C.1.T-T001-D002 | CEA: Uptake of D as function of C layer thickness in bulk and surface | 31.12.2021 |
| PWIE-SP C.1.T-T001-D003 | CEA: Preparation experiment with D for Gas/Gas permeation | 31.12.2021 |
| PWIE-SP C.1.T-T001-D004 | DIFFER: D concentration in the surface as function of temperature and plasma flux | 31.12.2021 |
| PWIE-SP C.1.T-T001-D005 | DIFFER: Compare hydrogen loading efficiency of plasma vs laser-based ELM simulation | 31.12.2021 |
| PWIE-SP C.1.T-T001-D006 | FZJ: Comparison of permeability W/Cu W/CuCrZ W/Steel vs pure substrates | 31.12.2021 |
| PWIE-SP C.1.T-T001-D007 | MPG: Permeability during ion beam permeation of W, Cu and heavy-alloys as function of temperature | 31.12.2021 |
| PWIE-SP C.1.T-T001-D008 | JSI, MPG: Permeated amount of D for atom and ion beam loading as function of temperature | 31.12.2021 |
| PWIE-SP C.1.T-T001-D009 | JSI, MPG: Permeated amount of D for atom and ion beam loading as function of temperature | 31.12.2021 |
| PWIE-SP C.1.T-T001-D010 | IPP\_LM: FIB/SEM/EDX analysis of multi material permeation samples (Samples from MPG, JSI) | 31.12.2021 |
| PWIE-SP C.1.T-T001-D011 | JSI: Permeation reduction factor of Chromia of Cr films on Eurofer | 31.12.2021 |
| PWIE-SP C.1.T-T001-D012 | OEAW, VR: D retention as function of flunence in "re-deposited" W on EUROFER | 31.12.2021 |
| PWIE-SP C.1.T-T001-D013 | OEAW, VR: D retention as function of flunence in "re-deposited" W on EUROFER | 31.12.2021 |
| PWIE-SP C.2.T-T001-D001 | Energy barriers for H to transition into the bulk (CEA) |  |
| PWIE-SP C.2.T-T001-D002 | Energy landscape of H at a W/Cu material interface (CEA) | 31.12.2021 |
| PWIE-SP C.2.T-T001-D003 | Stress and strain as function of defect concentration and H amount | 31.12.2021 |
| PWIE-SP C.3.T-T001-D001 | Removal rate of Wox layers as function of temperature (MPG, JSI) | 31.12.2021 |
| PWIE-SP C.3.T-T001-D002 | Uptake of D through oxide films as function of temperature and thickness (MPG, JSI) | 31.12.2021 |
| PWIE-SP C.3.T-T001-D003 | Release of D through oxide films from the W bulk as function of temperature and thickness (MPG, JSI) | 31.12.2021 |
| PWIE-SP C.3.T-T001-D004 | Removal rate of Wox layers as function of temperature (MPG, JSI) | 31.12.2021 |
| PWIE-SP C.3.T-T001-D005 | Uptake of D through oxide films as function of temperature and thickness (MPG, JSI) | 31.12.2021 |
| PWIE-SP C.3.T-T001-D006 | Uptake of D through oxide films as function of temperature and thickness (MPG, JSI) | 31.12.2021 |
| PWIE-SP C.3.T-T001-D007 | Difference in He retention in defect free and e-beam damaged W (MPG, ENEA) | 31.12.2021 |
| PWIE-SP C.3.T-T001-D008 | Influence of near surface He implantation on D release (JSI) | 31.12.2021 |
| PWIE-SP C.3.T-T001-D009 | Difference in He retention in defect free and e-beam damaged W (MPG, ENEA) | 31.12.2021 |
| PWIE-SP C.3.T-T001-D010 | Influence of near surface He implantation on D release (JSI) | 31.12.2021 |
| PWIE-SP C.4.T-T001-D001 | Influence of transmutation products produced by 30MeV p-irradiation on retention in W (FZJ) | 31.12.2021 |
| PWIE-SP D.1.T-T001-D001 | Plasma background parameters of WEST for modelling of impurity migration experiments (focus on He and D discharges) (CEA) | 31.12.2021 |
| PWIE-SP D.1.T-T001-D002 | Plasma background parameters of linear devices (in particular MAGNUM-PSI) for modelling of impurity migration experiments (DIFFER) | 31.12.2021 |
| PWIE-SP D.1.T-T001-D003 | Plasma background parameters of GyM for modelling of impurity migration experiments (ENEA) | 31.12.2021 |
| PWIE-SP D.1.T-T001-D004 | Plasma background parameters of W7-X for modelling of impurity migration experiments as well as PSI-2 (FZJ) | 31.12.2021 |
| PWIE-SP D.1.T-T001-D005 | Characterization of the emissive and collisional plasma sheath (considering ELMy discharges, rough surfaces, DT plasma) (FZJ) | 31.12.2021 |
| PWIE-SP D.1.T-T001-D006 | Semi-empirical analytic expressions of emitted current escaping form tungsten surfaces (inter- and intra-ELM conditions) (VR) | 31.12.2021 |
| PWIE-SP D.1.T-T001-D007 | Plasma background parameters of AUG and JET-ILW for modelling of impurity migration experiments (VTT) | 31.12.2021 |
| PWIE-SP D.2.T-T001-D001 | Dust production model for anomalous events and detached conditions (CEA) | 31.12.2021 |
| PWIE-SP D.2.T-T001-D002 | Rate coefficients for atomic/molecular process for detached conditions (FZJ) | 31.12.2021 |
| PWIE-SP D.2.T-T001-D003 | D3.1: Effect of seeding projectiles (e.g. Ar, Kr) on tungsten sputtering / D3.1; Electron impact cross sections (ionization, excitation), D3.3 Combine BCA and MD at transition from low energies to BCA limit (OAEW) | 31.12.2021 |
| PWIE-SP D.2.T-T001-D004 | Erosion information of surfaces including morphology, roughness, fuzz (OAEW) | 31.12.2021 |
| PWIE-SP D.2.T-T001-D005 | Model for dust production from melting; prediction of dust formation from molten metal, droplet ejection (VR) | 31.12.2021 |
| PWIE-SP D.2.T-T001-D006 | D5.1 Erosion and retention properties of redeposited tungsten, D5.2 Interaction potential of tungsten to be used for sputtering/reflection modelling / D5.3 Sputtering and reflection yields for various kinds of tungsten morphologies (VTT) | 31.12.2021 |
| PWIE-SP D.2.T-T001-D007 | Upgraded atomic/molecular database and CRM for molecules (VTT) | 31.12.2021 |
| PWIE-SP D.2.T-T001-D008 | Erosion information of 2D surfaces (various morphologies) in comparison to experiments (MPG) | 31.12.2021 |
| PWIE-SP D.3.T-T001-D001 | ERO2.0 simulations of tungsten transport in WEST, determination of main tungsten sources in WEST, comparison with spectroscopy (CEA) | 31.12.2021 |
| PWIE-SP D.3.T-T001-D002 | ERO2.0 simulations of dynamic morphology studies in GyM, ERO2.0 simulations of the transport of sputtered material in GyM, Global ERO2.0 modelling of erosion/deposition in AUG (ENEA) | 31.12.2021 |
| PWIE-SP D.3.T-T001-D003 | D3.1Model f.morphology effects&comparing modeling results w.experimental ion beam data,D3.2Local model. of 13C MPM injection experiment&comparison to post-mortem data,D3.3Erosion,impurity migration&deposition model. f.JET-ILW,incl. recessed areas(FZJ | 31.12.2021 |
| PWIE-SP D.3.T-T001-D004 | D4.1 Predictive tungsten migration in W7-X, D4.2 Beryllium/tungsten migration with realistic 3D ITER first wall. (MPG) | 31.12.2021 |
| PWIE-SP D.3.T-T001-D005 | ERO simulations of AUG and JET-ILW erosion and migration experiments (including nitrogen, tungsten and beryllium) and comparison with experimental data (VTT) | 31.12.2021 |
| PWIE-SP D.4.T-T001-D001 | Updated version of DIVGAS and benchmarking simulations studying the newly developed features of the code on the example of DEMO divertor. (KIT) | 31.12.2021 |
| PWIE-SP D.4.T-T001-D002 | Atomic and molecular fluxes to the wall surfaces (VTT) | 31.12.2021 |
| PWIE-SP X.1.T-T001-D001 | TALIF system installed at MAGNUM-PSI and conceptional CARS/SARS system for ro-vib. ground state distribution H2 in MAGNUM-PSI ready (DIFFER) | 31.12.2021 |
| PWIE-SP X.1.T-T001-D002 | VUV OES results H/H2 (DIFFER) | 31.12.2021 |
| PWIE-SP X.1.T-T001-D003 | Plasma velocity measurements (CTS) near the surface as function of ne (input SP D), and ne/Te measurements in PUP (DIFFER) | 31.12.2021 |
| PWIE-SP X.1.T-T001-D004 | VUV OES results H/H2 (FZJ) | 31.12.2021 |
| PWIE-SP X.1.T-T001-D005 | Conceptional design LIF for H/H2 measurements in PSI-2 ready (FZJ) | 31.12.2021 |
| PWIE-SP X.1.T-T001-D006 | VUV OES results H/H2 (CIEMAT) | 31.12.2021 |
| PWIE-SP X.1.T-T001-D007 | VUV OES results H/H2 (CU) | 31.12.2021 |
| PWIE-SP X.1.T-T001-D008 | Results feasibility multi-photon LIF for ro-vib. ground state distribution H2(v,J) (DCU) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D001 | Comparison of ps vs. ns LIBS: absolute content and composition | 31.12.2021 |
| PWIE-SP X.2.T-T001-D002 | Comparison SP vs. DP LIBS, or alternative LIBS signal enhancement methods: absolute fuel content in W samples and composition | 31.12.2021 |
| PWIE-SP X.2.T-T001-D003 | (CF)-LIBS (ps/ns or SP/DP) on samples from different toroidal devices: absolute content and composition (in depth) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D004 | (CF)-LIBS results He loaded samples and surface modifications | 31.12.2021 |
| PWIE-SP X.2.T-T001-D005 | Comparison of ps vs. ns LIBS: absolute content and composition (FZJ) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D006 | Comparison SP vs. DP LIBS, or alternative LIBS signal enhancement methods: absolute fuel content in W samples and composition (FZJ) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D007 | Modeling of wall conditioning RF-based plasmas (B128:C159KIPT) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D008 | (CF)-LIBS results He loaded samples and surface modifications (FZJ) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D009 | Reference measurements of outgassing, recycling, and retention after D plasma loading: absolute content and composition in W and reference samples (FZJ) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D010 | Report on CF-LIBS analysis by application of machine learning algorithm (IPPLM) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D011 | Comparison of ps vs. ns LIBS: absolute content and composition (CU) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D012 | (CF)-LIBS (ps/ns or SP/DP) on samples from different toroidal devices: absolute content and composition (in depth) (CU) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D013 | Analysis of Be containing coatings with (CF)-LIBS: absolute content and composition (CU) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D014 | (CF)-LIBS results He loaded samples and surface modifications (CU) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D015 | Comparison of ps vs. ns LIBS: absolute content and composition (UT) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D016 | (CF)-LIBS (ps/ns or SP/DP) on samples from different toroidal devices: absolute content and composition (in depth) (UT) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D017 | Analysis of Be containing coatings with (CF)-LIBS: absolute content and composition (UT) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D018 | (CF)-LIBS results He loaded samples and surface modifications (UT) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D019 | Reference measurements of outgassing, recycling, and retention after D plasma loading: absolute content and composition in W and reference samples (UT) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D020 | Comparison of ps vs. ns LIBS: absolute content and composition (ISSP-UL) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D021 | (CF)-LIBS (ps/ns or SP/DP) on samples from different toroidal devices: absolute content and composition (in depth) (ISSP-UL) | 31.12.2021 |
| PWIE-SP X.2.T-T001-D022 | Reference measurements of outgassing, recycling, and retention after D plasma loading: absolute content and composition in W and reference samples (DIFFER) | 31.12.2021 |
| PWIE-SP X.3.T-T001-D001 | ECWC, ICWC, and GDC plasma characterization in TOMAS (LPP-ERM/KMS) | 31.12.2021 |
| PWIE-SP X.3.T-T001-D002 | Report on fuel/impurity removal studies at reference samples in TOMAS (LPP-ERM/KMS) | 31.12.2021 |
| PWIE-SP X.3.T-T001-D003 | Report on a comparison of TOMAS studies with ICWC, ECWC and GDC and comparison with stellarator and tokamak experiments (LPP-ERM/KMS) | 31.12.2021 |
| PWIE-SP X.3.T-T001-D004 | Modeling of wall conditioning RF-based plasmas (LPP-ERM/KMS) | 31.12.2021 |
| PWIE-SP X.3.T-T001-D005 | ECWC, ICWC, and GDC plasma characterization in TOMAS (FZJ) | 31.12.2021 |
| PWIE-SP X.3.T-T001-D006 | Report on fuel/impurity removal studies at reference samples in TOMAS (FZJ) | 31.12.2021 |
| PWIE-SP X.3.T-T001-D007 | Pre- and post-characterization of samples used for cleaning in TOMAS (FZJ) | 31.12.2021 |
| PWIE-SP X.3.T-T001-D008 | ECWC, ICWC, and GDC plasma characterization in TOMAS (VR) | 31.12.2021 |
| PWIE-SP X.3.T-T001-D009 | Pre- and post-characterization of samples used for cleaning in TOMAS (VR) | 31.12.2021 |
| PWIE-SP X.3.T-T001-D010 | ECWC, ICWC, and GDC plasma characterization in TOMAS (KIPT) | 31.12.2021 |
| PWIE-SP X.3.T-T001-D011 | Modeling of wall conditioning RF-based plasmas (KIPT) | 31.12.2021 |
| PWIE-ADC.F.T-T001-D001 | Analysis and SOLPS-ITER modelling of DEMO XD considering the roles of connection length, flux flaring and neutral model (ENEA) | 31.12.2021 |
| PWIE-ADC.F.T-T001-D002 | Analysis and SOLPS-ITER modelling of DEMO SX considering the role of the neutral model and the dimensions of the outer divertor leg (ENEA) | 31.12.2021 |
| PWIE-ADC.F.T-T001-D003 | Analysis and SOLPS-ITER modelling of DEMO SF- including several configurations to understand the sensitivity of the solutions to the levels of separatrix and X-point separation (EFPL) | 31.12.2021 |
| PWIE-ADC.F.T-T001-D004 | Analysis and SOLPS-ITER modelling of DEMO SF- including several configurations to understand the sensitivity of the solutions to the levels of separatrix and X-point separation (EFPL) | 31.12.2021 |
| PWIE-ADC.F.T-T001-D005 | Development of simplified models based on simulation results for XD and SX to suggest validation methods for the PEX experiments (VTT) | 31.12.2021 |
| PWIE-ADC.F.T-T001-D006 | Sensitivity studies (transport coefficients, input power) for XD and SX configurations using SOLPS-ITER (IPP\_LM) | 31.12.2021 |
| PWIE-ADC.F.T-T001-D007 | Support on mesh creation and enhancing credibility of fluid neutrals results for all configurations applying hybrid numerical models (LPP-ERM/KMS) | 31.12.2021 |
| PWIE-ADC.F.T-T001-D008 | DEMO CDN modelling including drifts/core radiators with SOLPS-ITER (VTT) | 31.12.2021 |
| PWIE-ADC.G.T-T001-D001 | Initial reduced model from experimental ADC (MST1 or WP TE) 3D edge simulations and experimental data to scaling laws applicable to DEMO size machine (EFPL, CEA, MPG) | 31.12.2021 |
| PWIE-ADC.G.T-T001-D002 | Initial reduced model from experimental ADC (MST1 or WP TE) 3D edge simulations and experimental data to scaling laws applicable to DEMO size machine (EFPL, CEA, MPG) | 31.12.2021 |
| PWIE-ADC.G.T-T001-D003 | Comparison of experimental results and experimentally validated detachment models with SP-ADC.F simulations (EFPL, CEA, MPG) | 31.12.2021 |
| PWIE-ADC.H.T-T001-D001 | Engineering compatibility of best promising configurations described in WP ADC-DTT’s final report for DTT facility: recommendations for control and equilibria design (ENEA) | 31.12.2021 |
| PWIE-ADC.H.T-T001-D002 | Engineering compatibility of best promising configurations described in WP ADC-DTT’s final report for DTT facility: recommendations for control and equilibria design (ENEA) | 31.12.2021 |
| PWIE-ADC.H.T-T001-D003 | Engineering compatibility of best promising configurations described in WP ADC-DTT’s final report for DTT facility: recommendations for VDE and disruption consequences (ENEA) | 31.12.2021 |
| PWIE-ADC.I.T-T001-D001 | Plasma-Wall contact points during disruptions and initial evaluation of ADC transients for the heat flux impact point of view (ENEA) | 31.12.2021 |
| PWIE-ADC.I.T-T001-D002 | Plasma-Wall contact points during disruptions and initial evaluation of ADC transients for the heat flux impact point of view (ENEA) | 31.12.2021 |
| PWIE-ADC.I.T-T001-D003 | Plasma-Wall contact points during disruptions and initial evaluation of ADC transients for the heat flux impact point of view (ENEA) | 31.12.2021 |
| PWIE-ADC.I.T-T001-D004 | ADC modelling | 31.12.2021 |
| PWIE-PEX.PEX.T-T001-D001 | PEX resources | 31.12.2021 |
| PWIE-PM.1.T-T001-D001 | PL and PSO | 31.12.2021 |
| PWIE-PM.1.T-T001-D002 | Deputy PL | 31.12.2021 |
| PWIE-PM.1.T-T001-D003 | SPL | 31.12.2021 |
| PWIE-PM.1.T-T001-D004 | SPL | 31.12.2021 |
| PWIE-PM.1.T-T001-D005 | SPL | 31.12.2021 |
| PWIE-PM.1.T-T001-D006 | SPL | 31.12.2021 |
| PWIE-PM.1.T-T002-D001 | Unallocated hardware resources | 31.12.2021 |

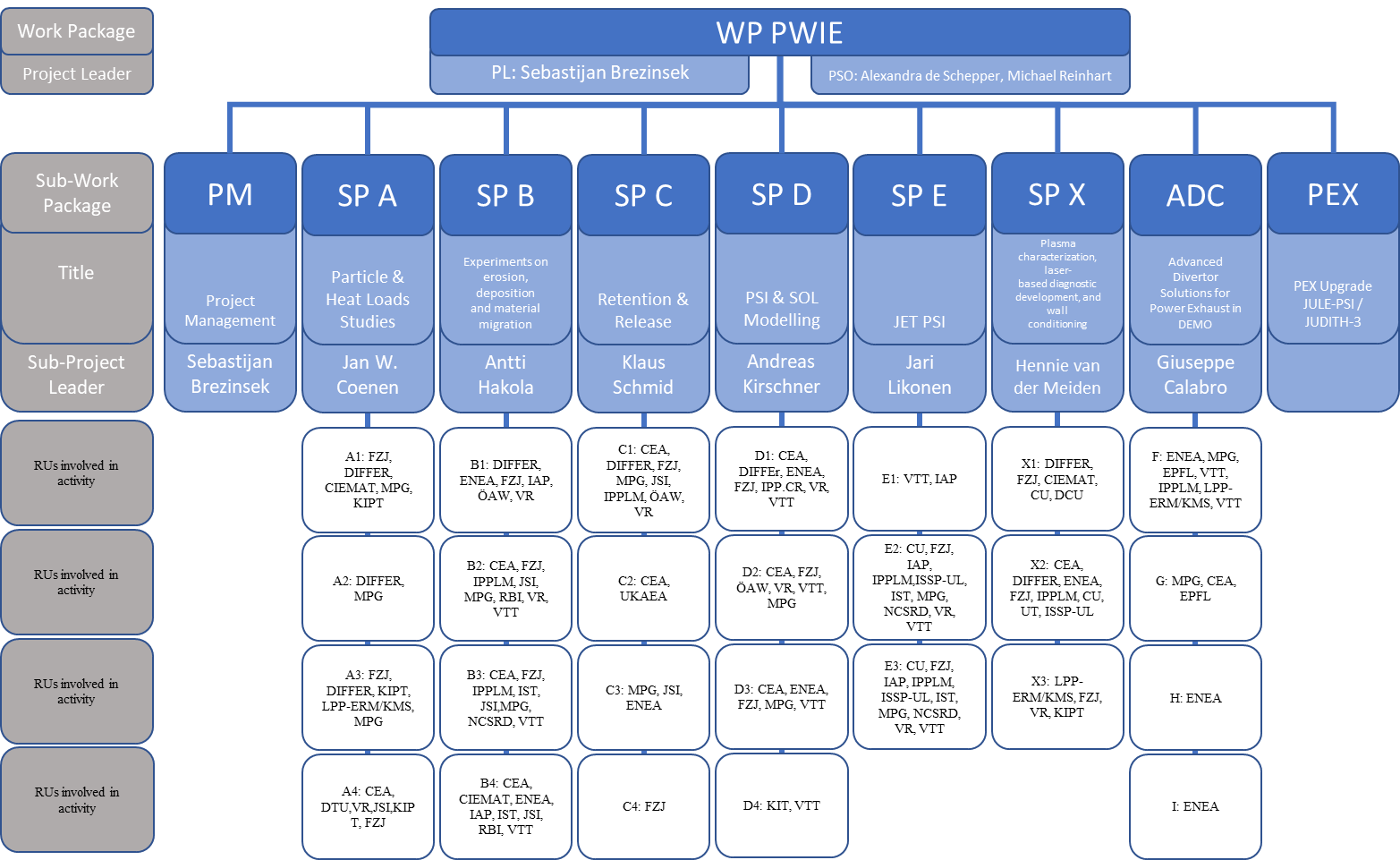
# ROLES AND RESPONSIBILITIES



**Figure 4: EUROfusion Organisational Chart**

Figure 4 shows the general structure of EUROfusion. Under the general program management of EUROfusion, scientific and engineering work is divided into the Fusion Science Department (FSD) and the Fusion Technology Department (FTD). WPPWIE is one of the Work Packages in the Experiment & Modelling area of FSD. There are connections between PWIE and other Work Packages, also in the FTD, which are described in section 1.2 of this PEP.

## WP Team Organisation



**Figure 4: WBS with beneficiaries per activity in WPPWIE**

The Project Leader manages and controls the Scientific Program and administration of WPPWIE. He is supported by 7 Sub-Project Leaders which oversee the scientific program in the Sub-Workpackages. The Project Support Office supports the Project Leader and Sub-Project Leaders in the administration of the Work Package.

In each Sub-Workpackage, scientists from different beneficiaries are working in several activities on their tasks and deliverables. The beneficiaries involved in each activity of WPPWIE are shown in figure 5. Scientists in a Sub-Workpackage coordinate either directly with their responsible Sub-Workpackage Leader, or via their beneficiary´s Scientific or Admin contact person. There is usually one Scientific and one Admin contact person per beneficiary. The names of the scientific contact persons are listed in table 6.

## WP Team Directory – Contact Details

Table 5: WPPWIE Project Management Team

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Surname | First Name | Role (in WP) | Beneficiary | Email | Office Phone |
| Brezinsek | Sebastijan | Project Leader | FZJ | s.brezinsek@fz-juelich.de | +492461616611 |
| Coenen | Jan Willem | Sub-Project Leader SP A | FZJ | j.w.coenen@fz-juelich.de | +492461615536 |
| Hakola | Antti | Sub-Project Leader SP B | VTT | antti.hakola@vtt.fi | +358207224875 |
| Schmid | Klaus | Sub-Project Leader SP C | MPG | Klaus.Schmid@ipp.mpg.de | +498932992228 |
| Kirschner | Andreas | Sub-Project Leader SP D | FZJ | a.kirschner@fz-juelich.de | +492461614277 |
| Likonen | Jari | Sub-Project Leader SP E | VTT | jari.likonen@vtt.fi |  |
| Van der Meiden | Hennie | Sub-Project Leader SP X | DIFFER | h.j.vandermeiden@differ.nl | +31306096804 |
| Calabro | Giuseppe | Deputy Project Leader SP ADC | ENEA | giuseppe.calabro@unitus.it |  |
| De Schepper | Alexandra | Project Support Office | FZJ | a.de.schepper@fz-juelich.de |  |
| Reinhart | Michael | Project Support Office | FZJ | m.reinhart@fz-juelich.de |  |
| Douai | David | EUROfusion Coordination officer | CEA | David.DOUAI@cea.fr |  |

Table 6: WPPWIE Scientific Contact Persons

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Surname | First Name | Beneficiary | Email | Office Phone |
| Widdowson | Anna | UKAEA | anna.widdowson@ukaea.uk | +44 1235 464874 |
| Fenzi | Christel | CEA | christel.fenzi@cea.fr | +33 4 4225 6116 |
| Tabares | Francisco L. | CIEMAT | tabares@ciemat.es | +34 913466458 |
| Veis | Pavel | CU | veis@fmph.uniba.sk | +421 2 60295106 |
| Leggate | Huw | DCU | Huw.leggate@dcu.ie | +353 833157029 |
| Westerhof | Egbert | DIFFER | e.westerhof@differ.nl | +31403334954 |
| Pantleon | Wolfgang | DTU | pawo@dtu.dk | +4545252315 |
| Iafrati | Matteo | ENEA | matteo.iafrati@enea.it | 00393396407099 |
| Martin | Yves | EPFL | yves.martin@epfl.ch | +41 21 6936511 |
| Unterberg | Bernhard | FZJ | b.unterberg@fz-juelich.de | +49 2461 61 4803 |
| Craciunescu | Teddy | IAP | c.teddy@ifa-mg.ro | +40766326625 |
| Tskhakaya | David | IPP.CR | tskhakaya@ipp.cas.cz | (+420) 26605 3941 |
| Chernyshove | Maryna | IPPLM | maryna.chernyshova@ifpilm.pl | +48226381005 ex 75 |
| Butikova | Jelena | ISSP-UL | jelena.butikova@cfi.lu.lv | +371 26483782 |
| Alves | Eduardo | IST | ealves@ctn.técnico.ulisboa.pt | +315 967084155 |
| Markelj | Sabina | JSI | sabina.markelj@ijs.si | +386 1 5885 265 |
| Makhlai | Vadym | KIPT | makhlay@kipt.kharkov.ua | +380573356305 |
| Ionesco-Bujor | Mihaela | KIT | mihaela.ionescu-bujor@kit.edu | +49 721 608-22245 |
| Terentyev | Dmitry | LPP-ERM-KMS | dterenty@sckcen.be | +32 14 33 31 97 |
| Wauters | Tom | LPP-ERM-KMS | t.wauters@fz-juelich.de | 0032 2 44 14128 |
| Jacob | Wolfgang | MPG | Wolfgang.Jacob@ipp.mpg.de | + 49 - 89 - 3299 2618 |
| Mergia | Konstantina | NCSRD | kmergia@ipta.demokritos.gr | +30 210 6503706 |
| Aumayr | Friedrich | OEAW | aumayr@iap.tuwien.ac.at | +43 664 605883471 |
| Probst | Michael | OEAW | michael.probst@uibk.ac.at | +43 512 507 26403 |
| Bogdanović Radović | Ivančica | RBI | iva@irb.hr | +385 1 457 1227 |
| Jõgi | Indrek | UT | indrek.jogi@ut.ee | -- |
| Petersson | Per | VR | per.petersson@ee.kth.se | +46 8 790 77 35 |
| Hakola | Antti | VTT | antti.hakola@vtt.fi | +358400102840 |

Table 7: WPPWIE Administrative Contact Persons

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Surname | First Name | Beneficiary | Email | Office Phone |
| Manhood | Sue | UKAEA | sue.manhood@ukaea.uk | 01235 4665343 |
| Coquillat | Anne | CEA | anne.coquillat@cea.fr | +33 4 4225 4975 |
| Barrera | Laura | CIEMAT | laura.barrera@ciemat.es | +34 913466161 |
| Matejčík | Štefan | CU | matejcik@fmph.uniba.sk | +421 2 60295686 |
| Leggate | Huw | DCU | Huw.leggate@dcu.ie | +353 833157029 |
| Schoonen | Rene | DIFFER | m.p.m.schoonen@differ.nl | +31403334817 |
| Korsholm | Søren Bang | DTU | sbko@fysik.dtu.dk | +4520645561 |
| Miele | Flavia | ENEA | flavia.miele@enea.it | 00390694005714 |
| Martin | Yves | EPFL | yves.martin@epfl.ch | +41 21 6936511 |
| Hoffmann | Marlene | FZJ | ma.hoffmann@fz-juelich.de | +49 2461 61 6584 |
| Craciunescu | Teddy | IAP | c.teddy@ifa-mg.ro | +40766326625 |
| Novak | Jan | IPP.CR | novak@ipp.cas.cz | (+420) 26605 2935 |
| Nadrowski | Pawel | IPPLM | pawel.nadrowski@ifpilm.pl | +48226381005 ex 22 |
| Butikova | Jelena | ISSP-UL | jelena.butikova@cfi.lu.lv | +371 26483782 |
| Gonçalves | Bruno | IST | bruno@ipfn.tecnico.ulisboa.pt | +351 962961061 |
| Mali | Marja | JSI | marja.mali@ijs.si | +386 1 4773 246 |
| Garkusha | Igor | KIPT | garkusha@ipp.kharkov.ua | +380573356122 |
| Henn | Michael | KIT | michael.henn@kit.edu | +49 721 608-25547 |
| Massaut | Vincent | LPP-ERM-KMS | vincent.massaut@sckcen.be | +32 14 33 35 01 |
| Schifflers | Benedicte | LPP-ERM-KMS | benedicte.schifflers@rma.ac.be | 0032 2 44 14119 |
| Erdmann | Michael | MPG | michael.erdmann@ipp.mpg.de | +49 89 3299 1282 |
| Angeli | Maria | NCSRD | mangel@central.ntua.gr | +302107723684 |
| Unger | Lätitia | OEAW | laetitia.unger@oeaw.ac.at | +43 515 81 2676 |
| Klasnić Kožar | Marijana | RBI | [Marijana.Klasnic.Kozar@irb.hr](mailto:Marijana.Klasnic.Kozar@irb.hr) | +385 1 457 1342 |
| Kiisk | Madis | UT | madis.kiisk@ut.ee | +372 737 4780 |
| Allgurén | Eva | VR | eva.allguren@chalmers.se | -- |
| Selin | Kirsi | VTT | kirsi.selin@vtt.fi | +358504398854 |

Table 8: WPPWIE Project Board RU Representatives

|  |  |
| --- | --- |
| Name | Years |
| Philippe Magaud (CEA) | 2021-2025 |
| Thomas Morgan (DIFFER) | 2021-2025 |
| Christian Linsmeier (FZJ) | 2021-2025 |
| Wolfgang Jacob (MPG) | 2021-2025 |
| Mihaela Ionescu-Bujor (KIT) | 2021-2023 |
| Paolo Innocente (ENEA) | 2021-2023 |
| Primoz Pelicon (JSI) | 2021-2023 |
| Eduardo Alves (IST) | 2021-2022 |
| Elzbieta Fortuna-Zalesna (IPPLM) | 2021-2022 |
| Fulvio Militello (UKAEA) | 2021-2022 |
| Anatoli Popov (ISSP-UL) | 2023 |
| Francisco Tabarés (CIEMAT) | 2023 |
| Renaud Dejarnac (IPP.CR) | 2023 |
| Anatoli Popov (ISSP-UL) | 2023-2025 |
| Andrea Sand (VTT) | 2024-2025 |
| Friedrich Aumayr (OEAW) | 2024-2025 |
| Marek Rubel (VR) | 2024-2025 |
| Vadym Makhlai (KIPT) | 2024-2025 |
| Tom Wauters(LPP-ERM-KMS) | 2024-2025 |

# RISK IDENTIFICATION

**Table 9: Risk identification for WPPWIE**

|  |  |  |
| --- | --- | --- |
| ***Risk Description*** | ***P*robability** | ***Action*** |
| Selected high heat flux facilities are not available due to technical issues (SP A) |  | Delay activities or transfer to other facilities not selected in the first place |
| Selected linear plasma devices are not available due to technical issues (SP A, B, C, X) |  | Delay activities or transfer to other linear plasma devices in the WP PWIE portfolio |
| Selected accelerator facilities are not available due to technical issues (SP A, B, C, X, E) |  | Delay activities or transfer to other Accelerator facilities in the WP PWIE portfolio |
| Selected TE or W7-X campaigns and attached PFC components for analysis / modelling delayed |  | Delay activities or redistribute resources to other toroidal facilities, linear plasma devices and laboratory experiments |
| Start of JULE-PSI operation delayed (SP C) |  | Compensate with PSI-2 operation as much as feasible and delay activities with Be an neutron damage to a later period |
| Funding for LIBS on a remote handling arm in JET not available or test not compatible with JET program (SP X, SP E) |  | Focus on LIBS on a remote handling arm in WEST (AIA) under WP TE as technical demonstration in a full W device (no Be and no T possible). Compensate with experience in JULE-PSI |
| Funding for LID-QMS in JET not available or test not compatible with JET program (SP X, SP E) |  | Transfer studies to FREDIS and JULE-PSI with residual JET-ILW samples. Reduce scope of this task. |
| No decision about the ADC solution for DEMO and DTT possible in given two years framework possible (SP ADC) |  | Coordination between involved EUROfusion partner in FTD and FSD on possible paths towards a timely ADC solution for DEMO. Assessment of consequences for a test in I-DTT. Increase of ADC resources will be required if more time is needed to conclude physics solutions. |
| Access to the CEA Tritium lab not granted or not covered by the available resources (SP C) |  | Reduce scope and focus on activities every other year with resources combined over 2 years. Check for alternatives at UKAEA or ISPPUL |
| Access to the LPP-ERM-KMS hot cell for material characterisation not granted or not covered by the available resources (SP A) |  | Reduce scope and focus on activities every other year with resources combined over 2 years. Check for alternatives at FZJ hot material laboratory. |
| Access to JET material samples from FP8 not accessible due to BREXIT restrictions (SP E) |  | Adaption of scope of SP E to the available samples from JET-ILE 1-3 available in European laboratories |
| Additional JET samples after DTE2 available and ready for analysis (SP E) |  | Prolongation of SP E with additional funding for the remaining time of FP9 in order to be able to wait for the reduction of neutron activation. Redistribution of samples to laboratories with T, Be and activation permission. Analysis done at start of PWIE. |

# RESOURCES

## Budget

The tables 10-14 show the indicative resources for WPPWIE from 2021-2025. The indicative resources are used for the long-term budget planning of WPPWIE and are not necessarily equal to the actual allocated resources approved by the General Assembly. The allocated resources of WPPWIE in 2021 can be found in Annex 1 and 2 of this document or on IMS. The allocated resources for 2022-2025 will only be available in the respective following years.

**Table 10: 2021 WPPWIE indicative resources profile**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Beneficiary**  **2021** | **Year** | **PM** | **PM costs [k€]** | **Equipment/ facility costs [k€]** | **Mission costs [k€]** | **Indirect costs [k€]** | **Total Resources [k€]** | **Consortium Contribution [k€]** |
| **CEA** | **2021** | 46,0 | 346,917 | 0,000 | 0,000 | 86,729 | 433,646 | 216,823 |
| **CIEMAT** | **2021** | 8,0 | 37,600 | 0,000 | 0,000 | 9,400 | 47,000 | 23,500 |
| **CU** | **2021** | 10,0 | 30,583 | 0,000 | 0,000 | 7,646 | 38,229 | 19,115 |
| **DCU** | **2021** | 3,0 | 19,575 | 0,000 | 0,000 | 4,894 | 24,469 | 12,234 |
| **DIFFER** | **2021** | 34,0 | 251,600 | 545,400 | 0,000 | 199,250 | 996,250 | 628,288 |
| **DTU** | **2021** | 5,0 | 37,625 | 0,000 | 0,000 | 9,406 | 47,031 | 23,516 |
| **ENEA** | **2021** | 55,8 | 312,071 | 4,500 | 0,000 | 79,143 | 395,714 | 196,728 |
| **EPFL** | **2021** | 5,0 | 49,917 | 0,000 | 0,000 | 12,479 | 62,396 | 31,198 |
| **FZJ** | **2021** | 185,1 | 1088,711 | 932,000 | 0,000 | 505,178 | 2525,889 | 1237,798 |
| **IAP** | **2021** | 11,0 | 53,167 | 0,000 | 0,000 | 13,292 | 66,458 | 33,229 |
| **IPP.CR** | **2021** | 5,0 | 14,917 | 0,000 | 0,000 | 3,729 | 18,646 | 9,323 |
| **IPPLM** | **2021** | 30,0 | 88,750 | 0,000 | 0,000 | 22,188 | 110,938 | 24,036 |
| **ISSP-UL** | **2021** | 3,0 | 9,525 | 0,000 | 0,000 | 2,381 | 11,906 | 5,953 |
| **IST** | **2021** | 5,5 | 22,523 | 6,000 | 0,000 | 7,131 | 35,653 | 16,324 |
| **JSI** | **2021** | 27,5 | 108,783 | 14,000 | 0,000 | 30,696 | 153,479 | 73,242 |
| **KIPT** | **2021** | 92,7 | 61,820 | 17,000 | 0,000 | 19,705 | 98,525 | 44,743 |
| **KIT** | **2021** | 9,0 | 63,675 | 0,000 | 0,000 | 15,919 | 79,594 | 39,797 |
| **LPP-ERM-KMS** | **2021** | 18,0 | 136,650 | 0,000 | 0,000 | 34,163 | 170,813 | 85,406 |
| **MPG** | **2021** | 63,7 | 452,270 | 83,000 | 0,000 | 133,818 | 669,088 | 327,298 |
| **NCSRD** | **2021** | 2,5 | 9,304 | 1,750 | 0,000 | 2,763 | 13,817 | 6,469 |
| **Not Allocated** | **2021** | 0,0 | 0,000 | 18,000 | 25,000 | 10,750 | 53,750 | 30,875 |
| **OEAW** | **2021** | 13,0 | 81,792 | 0,000 | 0,000 | 20,448 | 102,240 | 51,120 |
| **RBI** | **2021** | 8,1 | 23,596 | 9,000 | 0,000 | 8,149 | 40,745 | 18,121 |
| **UKAEA** | **2021** | 6,0 | 36,6000 | 0,000 | 0,000 | 9,150 | 45,750 | 22,875 |
| **UT** | **2021** | 9,0 | 23,400 | 0,000 | 0,000 | 5,850 | 29,250 | 14,625 |
| **VR** | **2021** | 30,9 | 202,133 | 18,750 | 0,000 | 55,221 | 276,104 | 133,367 |
| **VTT** | **2021** | 29,0 | 181,250 | 6,250 | 0,000 | 46,875 | 234,375 | 115,625 |

**Table 11: 2022 WPPWIE indicative resources profile**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Beneficiary**  **2022** | **Year** | **PM** | **PM costs [k€]** | **Equipment/ facility costs [k€]** | **Mission costs [k€]** | **Indirect costs [k€]** | **Total Resources [k€]** | **Consortium Contribution [k€]** |
| **CEA** | **2022** | 46,0 | 352,283 | 0,000 | 0,000 | 88,071 | 440,354 | 220,177 |
| **CIEMAT** | **2022** | 8,0 | 38,200 | 0,000 | 0,000 | 9,550 | 47,750 | 23,875 |
| **CU** | **2022** | 12,0 | 37,300 | 0,000 | 0,000 | 9,325 | 46,625 | 23,313 |
| **DCU** | **2022** | 3,0 | 19,875 | 0,000 | 0,000 | 4,969 | 24,844 | 12,422 |
| **DIFFER** | **2022** | 34,0 | 255,567 | 440,500 | 0,000 | 174,017 | 870,083 | 538,979 |
| **DTU** | **2022** | 5,0 | 38,208 | 0,000 | 0,000 | 9,552 | 47,760 | 23,880 |
| **ENEA** | **2022** | 56,1 | 318,608 | 6,000 | 0,000 | 81,152 | 405,760 | 201,377 |
| **EPFL** | **2022** | 5,0 | 50,667 | 0,000 | 0,000 | 12,667 | 63,333 | 31,667 |
| **FZJ** | **2022** | 199,2 | 1189,921 | 952,000 | 0,000 | 535,480 | 2677,402 | 1311,111 |
| **IAP** | **2022** | 25,0 | 122,708 | 0,000 | 0,000 | 30,677 | 153,385 | 76,693 |
| **IPP.CR** | **2022** | 5,0 | 15,167 | 0,000 | 0,000 | 3,792 | 18,958 | 9,479 |
| **IPPLM** | **2022** | 37,0 | 111,308 | 0,000 | 0,000 | 27,827 | 139,135 | 37,604 |
| **ISSP-UL** | **2022** | 15,0 | 48,375 | 0,000 | 0,000 | 12,094 | 60,469 | 30,234 |
| **IST** | **2022** | 16,7 | 69,875 | 7,000 | 0,000 | 19,219 | 96,094 | 46,297 |
| **JSI** | **2022** | 27,5 | 110,418 | 14,000 | 0,000 | 31,105 | 155,523 | 74,259 |
| **KIPT** | **2022** | 92,0 | 62,833 | 17,000 | 0,000 | 19,958 | 99,791 | 45,383 |
| **KIT** | **2022** | 9,0 | 64,650 | 0,000 | 0,000 | 16,163 | 80,813 | 40,406 |
| **LPP-ERM-KMS** | **2022** | 18,0 | 138,750 | 0,000 | 0,000 | 34,688 | 173,438 | 86,719 |
| **MPG** | **2022** | 67,1 | 483,968 | 87,500 | 0,000 | 142,867 | 714,334 | 352,162 |
| **NCSRD** | **2022** | 6,7 | 25,742 | 2,800 | 0,000 | 7,136 | 35,678 | 17,140 |
| **Not Allocated** | **2022** | 0,0 | 0,000 | 48,000 | 38,000 | 21,500 | 107,500 | 57,250 |
| **OEAW** | **2022** | 13,0 | 83,092 | 0,000 | 0,000 | 20,773 | 103,865 | 51,932 |
| **RBI** | **2022** | 8,6 | 25,632 | 10,800 | 0,000 | 9,108 | 45,540 | 20,070 |
| **UKAEA** | **2022** | 17,0 | 105,258 | 0,000 | 0,000 | 26,315 | 131,573 | 65,786 |
| **UT** | **2022** | 9,0 | 23,775 | 0,000 | 0,000 | 5,944 | 29,719 | 14,859 |
| **VR** | **2022** | 44,4 | 295,127 | 22,500 | 0,000 | 79,407 | 397,034 | 192,895 |
| **VTT** | **2022** | 42,0 | 266,573 | 6,250 | 0,000 | 68,206 | 341,029 | 168,955 |

**Table 12: 2023 WPPWIE indicative resources profile**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Beneficiary**  **2023** | **Year** | **PM** | **PM costs [k€]** | **Equipment/ facility costs [k€]** | **Mission costs [k€]** | **Indirect costs [k€]** | **Total Resources [k€]** | **Consortium Contribution [k€]** |
| **CEA** | **2023** | 43,0 | 334,325 | 0,000 | 0,000 | 83,581 | 417,906 | 208,953 |
| **CIEMAT** | **2023** | 8,0 | 38,800 | 0,000 | 0,000 | 9,700 | 48,500 | 24,250 |
| **CU** | **2023** | 12,0 | 37,900 | 0,000 | 0,000 | 9,475 | 47,375 | 23,688 |
| **DCU** | **2023** | 3,0 | 20,175 | 0,000 | 0,000 | 5,044 | 25,219 | 12,609 |
| **DIFFER** | **2023** | 34,0 | 259,250 | 440,700 | 0,000 | 174,988 | 874,938 | 541,456 |
| **DTU** | **2023** | 5,0 | 38,792 | 0,000 | 0,000 | 9,698 | 48,490 | 24,245 |
| **ENEA** | **2023** | 21,0 | 121,331 | 6,000 | 0,000 | 31,833 | 159,163 | 78,082 |
| **FZJ** | **2023** | 231,7 | 1405,465 | 952,000 | 0,000 | 589,366 | 2946,831 | 1486,176 |
| **IAP** | **2023** | 25,0 | 124,583 | 0,000 | 0,000 | 31,146 | 155,729 | 77,865 |
| **IPP.CR** | **2023** | 5,0 | 15,375 | 0,000 | 0,000 | 3,844 | 19,219 | 9,609 |
| **IPPLM** | **2023** | 32,0 | 97,600 | 0,000 | 0,000 | 24,400 | 122,000 | 32,406 |
| **ISSP-UL** | **2023** | 15,0 | 49,125 | 0,000 | 0,000 | 12,281 | 61,406 | 30,703 |
| **IST** | **2023** | 16,7 | 70,933 | 7,200 | 0,000 | 19,533 | 97,666 | 47,035 |
| **JSI** | **2023** | 27,4 | 111,818 | 14,000 | 0,000 | 31,455 | 157,273 | 75,134 |
| **KIPT** | **2023** | 91,6 | 63,336 | 17,000 | 0,000 | 20,084 | 100,420 | 45,701 |
| **KIT** | **2023** | 9,0 | 65,625 | 0,000 | 0,000 | 16,406 | 82,031 | 41,016 |
| **LPP-ERM-KMS** | **2023** | 13,0 | 101,725 | 0,000 | 0,000 | 25,431 | 127,156 | 63,578 |
| **MPG** | **2023** | 55,0 | 402,124 | 87,500 | 0,000 | 122,406 | 612,030 | 301,027 |
| **NCSRD** | **2023** | 4,7 | 18,329 | 2,800 | 0,000 | 5,282 | 26,412 | 12,506 |
| **Not Allocated** | **2023** | 0,0 | 0,000 | 48,000 | 36,000 | 21,000 | 105,000 | 55,500 |
| **OEAW** | **2023** | 13,0 | 84,283 | 0,000 | 0,000 | 21,071 | 105,354 | 52,677 |
| **RBI** | **2023** | 8,6 | 25,751 | 10,700 | 0,000 | 9,113 | 45,564 | 20,106 |
| **UKAEA** | **2023** | 17 | 106,958 | 0,000 | 0,000 | 26,740 | 133,698 | 66,849 |
| **UT** | **2023** | 9,0 | 24,150 | 0,000 | 0,000 | 6,038 | 30,188 | 15,094 |
| **VR** | **2023** | 44,3 | 299,228 | 22,500 | 0,000 | 80,432 | 402,159 | 195,458 |
| **VTT** | **2023** | 35,0 | 225,265 | 6,250 | 0,000 | 57,879 | 289,394 | 143,135 |

**Table 13: 2024 WPPWIE indicative resources profile**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Beneficiary**  **2024** | **Year** | **PM** | **PM costs [k€]** | **Equipment/ facility costs [k€]** | **Mission costs [k€]** | **Indirect costs [k€]** | **Total Resources [k€]** | **Consortium Contribution [k€]** |
| **CEA** | **2024** | 42,0 | 331,450 | 0,000 | 0,000 | 82,863 | 414,313 | 207,156 |
| **CIEMAT** | **2024** | 8,0 | 39,333 | 0,000 | 0,000 | 9,833 | 49,167 | 24,583 |
| **CU** | **2024** | 10,0 | 32,000 | 0,000 | 0,000 | 8,000 | 40,000 | 20,000 |
| **DCU** | **2024** | 3,0 | 20,475 | 0,000 | 0,000 | 5,119 | 25,594 | 12,797 |
| **DIFFER** | **2024** | 34,0 | 263,217 | 440,700 | 0,000 | 175,979 | 879,896 | 543,935 |
| **DTU** | **2024** | 5,0 | 39,375 | 0,000 | 0,000 | 9,844 | 49,219 | 24,609 |
| **ENEA** | **2024** | 21,0 | 123,026 | 6,000 | 0,000 | 32,256 | 161,282 | 79,138 |
| **FZJ** | **2024** | 260,3 | 1602,768 | 952,000 | 0,000 | 638,692 | 3193,460 | 1678,084 |
| **IAP** | **2024** | 11,0 | 55,642 | 0,000 | 0,000 | 13,910 | 69,552 | 34,776 |
| **IPP.CR** | **2024** | 5,0 | 15,625 | 0,000 | 0,000 | 3,906 | 19,531 | 9,766 |
| **IPPLM** | **2024** | 26,0 | 80,600 | 0,000 | 0,000 | 20,150 | 100,750 | 21,313 |
| **ISSP-UL** | **2024** | 3,0 | 9,975 | 0,000 | 0,000 | 2,494 | 12,469 | 6,234 |
| **IST** | **2024** | 6,0 | 25,684 | 8,400 | 0,000 | 8,521 | 42,605 | 19,200 |
| **JSI** | **2024** | 27,4 | 113,212 | 14,000 | 0,000 | 31,803 | 159,015 | 76,006 |
| **KIPT** | **2024** | 91,2 | 63,840 | 17,000 | 0,000 | 20,210 | 101,050 | 46,020 |
| **KIT** | **2024** | 9,0 | 66,600 | 0,000 | 0,000 | 16,650 | 83,250 | 41,625 |
| **LPP-ERM-KMS** | **2024** | 13,0 | 103,242 | 0,000 | 0,000 | 25,810 | 129,052 | 64,526 |
| **MPG** | **2024** | 50,8 | 377,042 | 87,500 | 0,000 | 116,135 | 580,677 | 285,342 |
| **NCSRD** | **2024** | 2,4 | 9,618 | 1,750 | 0,000 | 2,842 | 14,210 | 6,669 |
| **Not Allocated** | **2024** | 0,0 | 0,000 | 48,000 | 32,000 | 20,000 | 100,000 | 52,000 |
| **OEAW** | **2024** | 13,0 | 85,583 | 0,000 | 0,000 | 21,396 | 106,979 | 53,490 |
| **RBI** | **2024** | 9,1 | 27,847 | 12,600 | 0,000 | 10,112 | 50,558 | 22,130 |
| **UKAEA** | **2024** | 6,0 | 38,800 | 0,000 | 0,000 | 9,575 | 47,875 | 23,938 |
| **UT** | **2024** | 9,0 | 24,525 | 0,000 | 0,000 | 6,131 | 30,656 | 15,328 |
| **VR** | **2024** | 34,3 | 234,887 | 22,500 | 0,000 | 64,347 | 321,733 | 155,237 |
| **VTT** | **2024** | 22,0 | 143,851 | 6,500 | 0,000 | 37,588 | 187,939 | 92,348 |

**Table 14: 2025 WPPWIE indicative resources profile**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Beneficiary**  **2025** | **Year** | **PM** | **PM costs [k€]** | **Equipment/ facility costs [k€]** | **Mission costs [k€]** | **Indirect costs [k€]** | **Total Resources [k€]** | **Consortium Contribution [k€]** |
| **CEA** | **2025** | 42,0 | 336,350 | 0,000 | 0,000 | 84,088 | 420,438 | 210,219 |
| **CIEMAT** | **2025** | 8,0 | 39,933 | 0,000 | 0,000 | 9,983 | 49,917 | 24,958 |
| **CU** | **2025** | 10,0 | 32,500 | 0,000 | 0,000 | 8,125 | 40,625 | 20,313 |
| **DCU** | **2025** | 3,0 | 20,800 | 0,000 | 0,000 | 5,200 | 26,000 | 13,000 |
| **DIFFER** | **2025** | 34,0 | 267,183 | 420,500 | 0,000 | 171,921 | 859,604 | 528,740 |
| **DTU** | **2025** | 5,0 | 39,958 | 0,000 | 0,000 | 9,990 | 49,948 | 24,974 |
| **ENEA** | **2025** | 21,0 | 124,834 | 6,000 | 0,000 | 32,709 | 163,543 | 80,271 |
| **FZJ** | **2025** | 248,3 | 1551,875 | 952,000 | 0,000 | 625,969 | 3129,844 | 1631,625 |
| **IAP** | **2025** | 11,0 | 56,467 | 0,000 | 0,000 | 14,117 | 70,583 | 35,292 |
| **IPP.CR** | **2025** | 5,0 | 15,833 | 0,000 | 0,000 | 3,958 | 19,792 | 9,896 |
| **IPPLM** | **2025** | 26,0 | 81,683 | 0,000 | 0,000 | 20,421 | 102,104 | 21,599 |
| **ISSP-UL** | **2025** | 3,0 | 10,125 | 0,000 | 0,000 | 2,531 | 12,656 | 6,328 |
| **IST** | **2025** | 5,9 | 25,949 | 8,400 | 0,000 | 8,587 | 42,937 | 19,366 |
| **JSI** | **2025** | 27,3 | 114,786 | 14,000 | 0,000 | 32,197 | 160,983 | 76,993 |
| **KIPT** | **2025** | 90,8 | 64,345 | 17,000 | 0,000 | 20,336 | 101,681 | 46,339 |
| **LPP-ERM-KMS** | **2025** | 13,0 | 104,758 | 0,000 | 0,000 | 26,190 | 130,948 | 65,474 |
| **MPG** | **2025** | 50,6 | 381,608 | 87,500 | 0,000 | 117,277 | 586,385 | 288,185 |
| **NCSRD** | **2025** | 2,4 | 9,760 | 1,750 | 0,000 | 2,878 | 14,388 | 6,755 |
| **Not Allocated** | **2025** | 0,0 | 0,000 | 48,000 | 32,000 | 20,000 | 100,000 | 52,000 |
| **OEAW** | **2025** | 13,0 | 86,883 | 0,000 | 0,000 | 21,721 | 108,604 | 54,302 |
| **RBI** | **2025** | 9,1 | 28,117 | 12,600 | 0,000 | 10,179 | 50,896 | 22,296 |
| **UKAEA** | **2025** | 6,0 | 38,850 | 0,000 | 0,000 | 9,713 | 48,563 | 24,281 |
| **UT** | **2025** | 9,0 | 24,900 | 0,000 | 0,000 | 6,225 | 31,125 | 15,563 |
| **VR** | **2025** | 29,2 | 203,392 | 22,500 | 0,000 | 56,473 | 282,365 | 135,561 |
| **VTT** | **2025** | 21,9 | 145,718 | 6,250 | 0,000 | 37,992 | 189,960 | 93,418 |

## Human Resources Breakdown for 2021 (Manpower broken down by WP Deliverables)

**Table 15: 2021 WPPWIE human resources breakdown per activity**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **RU / Activity** | **PM** | **A.1** | **A.2** | **A.3** | **A.4** | **B.1** | **B.2** | **B.3** | **B.4** | **C.1** | **C.2** | **C.3** | **C.4** | **D.1** | **D.2** | **D.3** | **D.4** | **X.1** | **X.2** | **X.3** | **ADC.F** | **ADC.G** | **ADC.H** | **ADC.I** | **TOTAL** |
| **CEA** |  |  |  |  | 6 |  | 2 | 2 | 2 | 15 | 9 |  |  | 2 | 2 | 2 |  |  | 2 |  |  | 2 |  |  | **46** |
| **CIEMAT** |  | 3 |  |  |  |  |  |  | 3 |  |  |  |  |  |  |  |  | 2 |  |  |  |  |  |  | **8** |
| **CU** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 2 | 8 |  |  |  |  |  | **10** |
| **DCU** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 3 |  |  |  |  |  |  | **3** |
| **DIFFER** |  | 4 | 7 | 3 |  | 4 |  |  |  | 4 |  |  |  | 2 |  |  |  | 6 | 2 |  |  |  |  |  | **32** |
| **DTU** |  |  |  |  | 5 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **5** |
| **ENEA** |  |  |  |  |  | 4 |  |  | 3 |  |  | 3 |  | 2 |  | 5 |  |  | 4 |  | 5 |  | 15 | 10 | **51** |
| **EPFL** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 3 | 2 |  |  | **5** |
| **FZJ** | 15,6 | 9 |  | 8 | 2 | 7 | 2 | 2 |  | 11 |  |  | 3 | 4 | 1 | 16 |  | 2 | 9 | 4 |  |  |  |  | **95,6** |
| **IAP** |  |  |  |  |  | 2 |  |  | 9 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **11** |
| **IPP.CR** |  |  |  |  |  |  |  |  |  |  |  |  |  | 5 |  |  |  |  |  |  |  |  |  |  | **5** |
| **IPPLM** |  |  |  |  |  |  | 2 | 3 |  | 4 |  |  |  |  |  |  |  |  | 2 |  | 2 |  |  |  | **13** |
| **ISSP-UL** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 3 |  |  |  |  |  | **3** |
| **IST** |  |  |  |  |  |  |  | 2 | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **4** |
| **JSI** |  |  |  |  | 3 |  | 3 | 1 | 3 | 7 |  | 7 |  |  |  |  |  |  |  |  |  |  |  |  | **24** |
| **KIPT** |  | 30 |  | 15 | 15 |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 4 |  |  |  |  | **64** |
| **KIT** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 9 |  |  |  |  |  |  |  | **9** |
| **LPP-ERM-KMS** |  |  |  | 4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 9 | 6 |  |  |  | **19** |
| **MPG** |  | 2,5 | 2 | 2,5 |  |  | 6 | 5 |  | 4 |  | 13 |  |  | 3 | 2 |  |  |  |  | 4 | 6 |  |  | **50** |
| **NCSRD** |  |  |  |  |  |  |  | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **2** |
| **Not Allocated** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **0** |
| **OEAW** |  |  |  |  |  | 5 |  |  |  | 3 |  |  |  |  | 5 |  |  |  |  |  |  |  |  |  | **13** |
| **RBI** |  |  |  |  |  |  | 3 |  | 2 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | **5** |
| **UKAEA** |  |  |  |  |  |  |  |  |  |  | 6 |  |  |  |  |  |  |  |  |  |  |  |  |  | **6** |
| **UT** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | 9 |  |  |  |  |  | **9** |
| **VTT** |  |  |  |  |  |  | 2 | 2 | 2 |  |  |  |  | 3 | 6 | 4 | 2 |  |  |  | 4 |  |  |  | **25** |
| **VR** |  |  |  |  | 6 | 3 | 2 |  |  | 3 |  |  |  | 4 | 7 |  |  |  |  | 3 |  |  |  |  | **28** |
| **TOTAL** | 15,6 | 48,5 | 9 | 32,5 | 37 | 25 | 22 | 19 | 26 | 51 | 15 | 23 | 3 | 22 | 24 | 29 | 11 | 15 | 39 | 20 | 24 | 10 | 15 | 10 | **545,6** |

## Equipment and Other Goods and Services

**Table 16: 2021 WPPWIE Equipment and other Goods and Services (indicative for 2022-2025)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| ID | Title of E&GS | Research activity requiring the E&GS | Planned days of use | Beneficiary |
| EGS01 |  |  |  |  |
| EGS02 |  |  |  |  |
| EGS03 |  |  |  |  |

## Use of Facilities

The following tables show the use of facilities in WPPWIE from 2021-2025. The numbers given for the years 2022-2025 are only indicative and subject to change.

**Table 17: WPPWIE facilities funded at 70% (indicative for 2022-2025)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ID | Facility Name | Hosting institute | Research activity | Planned days of use | Eurofusion days/total days |
| UF01 | PSI-2 | FZJ | SP A SPB SPC SPX | 2021  2022  2023  2024-2025 | 70/120  70/120  45/105  40/85 |
| UF02 | MAGNUM-PSI | DIFFER | SP A SPB SPC SPX | 2021  2022-2025 | 27/104  40/104 |
| UF03 | JULE-PSI | FZJ | SPA SPB SPC SPX | 2023  2024-2025 | 20/60  40/60 |
| UF04 | UPP | DIFFER | SPC SPX | 2021  2022-2025 | 12/150  15/150 |

Table 18: WPPWIE facilities funded at 40% (indicative for 2022-2025)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| ID | Facility Name | Hosting institute | Research activity | Planned days of use | WPPWIE days/total days |
| UF05 | JUDITH-2 | FZJ | SPA | 2021  2022  2023-2025 | 20/150  20/150  25/150 |
| UF06 | GLADIS | MPG | SPA | 2021  2022  2023-2025 | 8/80  8/80  10/80 |
| UF07 | QSPA | KIPT | SPA | 2021  2022-20225 | 20/200  20/200 |
| UF08 | OLMAT | CIEMAT | SPA | 2021  2022-2025 | 4/--  4/-- |
| UF09 | GYM | ENEA | SPB | 2021  2022-2025 | 15/100  20/100 |
| UF10 | TOMAS | FZJ | SPX | 2021  2022-2025 | 15/50  20/50 |
| UF11 | Accelerator | MPG | SPA SPB SPC | 2021  2022-2025 | 52/180  52/180 |
| UF12 | Accelerator | DIFFER | SPB SPC SPX | 2021  2022-2025 | 15/160  15/160 |
| UF13 | Accelerator | FZJ | SPB SPX | 2021  2022-2023  2024-2025 | 12/30  12/30  14/30 |
| UF14 | Accelerator | VR | SPB SPX | 2021  2022-2025 | 15/215  18/215 |
| UF15 | Accelerator | JSI | SPB SPC | 2021  2022-2025 | 20d/3500h  20d/3500h |
| UF16 | Accelerator | RBI | SPB | 2021  2022-2023  2024-2025 | 10/185  12/185  14/185 |
| UF17 | Accelerator | VTT | SPB | 2021  2022-2025 | 5/200  5/200 |
| UF18 | Accelerator | IST | SPB | 2021  2022-2023  2024-2025 | 10/230  12/230  14/230 |
| UF19 | Accelerator | NCSRD | SPB | 2021  2022-2023  2024-2025 | 5/140  8/140  5/140 |

## Facility Investment, i.e. new build or upgrade

**Not applicable in WP PWIE in 2021**

## International Collaboration

Table 19: WPPWIE international collaborations (indicative for 2022-2025)

|  |  |  |  |
| --- | --- | --- | --- |
| ID | International Collaboration in WP Activities | Planned period(s) of engagement | Beneficiary |
| IC01 | SP D.3:  LHD in Japan | 2021-2025 | -- |
| IC02 | SP D.3:  PISCES in US | 2021-2025 | -- |
| IC03 | SP D.3:  EAST in China | 2021-2025 | -- |
| IC04 | SP X.1:  EU-Japan (NAGDIS, LHD) | 2021-2025 | -- |
| IC05 | SP ADC.F:  EU-CHINA | 2021-2022 | -- |
| IC06 | SP ADC.G:  EU-CHINA | 2021-2022 | -- |
| IC07 | SP ADC.H:  EU-CHINA | 2021-2022 | -- |
| IC08 | SP ADC.I:  EU-CHINA | 2021-2022 | -- |

# REFERENCED DOCUMENTS

**ANNEX 1: WP PWIE 2021 activity descriptions**

**ANNEX 2: WP PWIE 2021 facility resources summary**

## ANNEX 1: WPPWIE 2021 Activity Descriptions

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SPA / Particle & Heat Load Studies in preparation of the exploitation of ITER and DEMO |  |  |
| **Task title:** | SP A.1 Synergistic Load Studies of Plasma-Facing Materials for ITER & DEMO | **Task Ref. Nr.:** | PWIE-SP A.1.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  J.W. Coenen ( FZJ) | **Issue:** | 1 |
| **Local RO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer (PMU):** | David Douai (CO) | **Date:** | 22-Feb-2021 |
| **Reference Annual Workplan:** *will be added later* | | | |
| This Task contributes to the qualification of current baseline materials and beyond by different heat load treatment techniques and quantifying the difference in damage behavior by the different loading techniques as well as the additional impact of fuel species and other fusion relevant conditions. In addition, it helps with the long-term activities in the FSD and FTD to predict the power load capabilities and damage thresholds for materials envisioned for current and future Fusion Devices.  This includes the qualification of materials for W7-X (in collaboration with WP DIV and WP W7X) and preparation of exposures in WEST & AUG (via WP TE). The basis for the tests are materials defined by WP MAT and WP DIV, ITER as baseline for the use in current devices as well as DEMO.  Link with activities related to neutron testing when appropriate combine with plasma loading e.g. JULE-PSI. | | | |
| **Inputs required:**   * Materials provided by the parties in-line with Tasks * Heat-flux profiles and specifications from ITER/W7-X/WEST * Thermomechanical properties where available * Samples from pre-damaged experiments in WEST – (WP TE) /Limiter samples (DEMO/WP DIV)/ Composite and Alloy Samples (WP PRD) | | | |
| **Tasks to be performed:**   * Establish a test matrix for Materials utilized in WEST & ITER with respect to updated load specifications. in the available devices (DIFFER, FZJ, MPG) * Study the impact of synergistic loads on ITER and DEMO relevant baseline Materials (tungsten) and new materials developments with Laser (Laser at PSI-2) and e-beam (JUDITH) as well as steady-state plasma exposure (He, H). A special focus will be the qualification of these materials under high cycle numbers and seed-impurities exposure. (FZJ) * Post-mortem analysis will characterize the induced surface modifications and damages as well as investigate changes of the materials properties due to e.g. recrystallization behavior and/or surface morphology changes (FZJ, MPG, DIFFER, KIPT) * Determine underlying mechanisms of evolution of crack propagation in materials for ITER and current day devices (FZJ, DIFFER, KIPT, MPG) * Qualify W materials for use in W7-X (MPG, FZJ) * Synergy effects from sequential stationary (PSI-2 / MAGNUM-PSI) and transient (QSPA) plasma loads. (DIFFER, MPG, FZJ, KIPT) * Studies of fatigue cracks formation in deformed/re-crystalized W, fatigue damage of Wf/W wires, latticing W etc. * Combination of pulsed and steady state loading (e.g. behaviour of QSPA pre-damaged targets in PSI-2, JUIDTH compared with reference samples) (FZJ, KIPT) * Study the Behavior of pre-cracked samples under edge loading conditions - links to HHF facilities such as JUDITH and WEST (DIFFER, FZJ) | | | |
| **Deliverables:**   |  |  | | --- | --- | | **Deliverable ID** | **Deliverable Title** | | D001 | Damage threshold for different W materials at varying loading conditions in matrix form  & Understanding the damage mechanisms and changes in material properties, influence of / changes in the retention behavior (FZJ) | | D002 | Pre-crack damage evolution and erosion under transient loading (DIFFER) | | D003 | Qualification of OLMAT as HHF facility in comparison with QSPA and GLADIS (CIEMAT) | | D004 | Qualification of W-Heavy Alloys for use in W7-X in conjunction with test on new tungsten mock-ups (WP MAT) and PFUs for WEST (WP TE) (MPG) | | D005 | Qualification of current baseline materials under transient (HHF plasma load with QSPA) and steady state loading (PSI-2, JUDITH) (KIPT) | | | | |
| **Management Information**  **Human Resources**:   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | M. Wirtz | FZJ | 9 | D001 (T.Loewenhoff, M.Gago, D.Dorow-Gerspach) | | T. Morgan | DIFFER | 4 | D002 | | P. Tabares | CIEMAT | 3 | D003 | | H. Greuner | MPG | 2,5 | D004 (Henri Greuner (H. Maier, M. Balden) | | I. Garkusha | KIPT | 30 | D005 | | **Total** |  | 48.5 |  |   **Machine Resources:**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | PSI-2 | FZJ | 14 | D001 | | JUDITH | FZJ | 10 | D001 | | GLADIS | MPG | 4 | D004 | | MAGNUM-PSI | DIFFER | 4 | D002 | | QSPA | KIPT | 10 | D005 | | OLMAT | CIEMAT | 4 | D003 |   **Other resources:**  **Collaborations:**   * WP DIV, MAT, PRD in FTD * WP TE, W7X in FSD * IO and ITPA DivSOL group (Task on Lifetime Assessment of 1st ITER Divertor)   **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SPA / Particle & Heat Load Studies in preparation of the exploitation of ITER and DEMO |  |  |
| **Task title:** | SP A.2 High Particle Fluence Exposures of Plasma-Facing Components for ITER | **Task Ref. Nr.:** | PWIE-SP A.2.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  J.W. Coenen ( FZJ) | **Issue:** | 1 |
| **Local RO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer (PMU):** | David Douai (CO) | **Date:** | 22-Feb-2021 |
| **Reference Annual Workplan:** *will be added later* | | | |
| This Task is envisioned to utilize existing high fluence devices such as MAGNUM-PSI, but also in future e.g. machines under construction to allow extrapolation of data from existing materials studies towards the effect of high flux and fluence on materials and components. Particular this includes W PFUs for ITER and their use in WEST, but also studies related to pre-damaged (e.g. self-damage, cracking etc.) materials for exposure. The task includes pre- and post analysis in collaboration with SP B.  Where appropriate this will link with WP TE in order to give access to relevant tokamak exposures and experiments. Strong links to other SP A Tasks. | | | |
| **Inputs required:**   * W components produced e.g. by ENEA via WP DIV * PFUs and similar | | | |
| **Tasks to be performed:**   * Recrystallization behavior of DEMO tungsten grades under high flux/fluence plasma loading (DIFFER) * Pre- and post analysis of materials and components (MPG) * Further analysis linked to facilities and staffing in SP B | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | **Deliverable ID** | **Deliverable Title** | | D001 | Influence of plasma on Rx under slow transient loading (DIFFER) | | D002 | Pre- and post characterization of samples (MPG) | | | | |
| **Management Information**  **Human Resources**:   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | T. Morgan | DIFFER | 7 | D001 | | M. Balden | MPG | 2 | D002 (S. Elgeti) | | **Total** |  | 9 |  |   **Machine Resources:**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | MAGNUM-PSI | DIFFER | 7 | D001 |   **Other resources:**    **Collaborations:**   * WP DIV, MAT, PRD in FTD   **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SPA Particle & Heat Load Studies in preparation of the exploitation of ITER and DEMO |  |  |
| **Task title:** | SP A.3 / Advanced Materials under thermo-mechanical and plasma loads | **Task Ref. Nr.:** | PWIE-SP A.3.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  J.W. Coenen ( FZJ) | **Issue:** | 1 |
| **Local RO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer (PMU):** | David Douai (CO) | **Date:** | 22-Feb-2021 |
| **Reference Annual Workplan:** *will be added later* | | | |
| Develop qualification methods for advanced materials for ITER & beyond by different thermomechanical test procedures, heat load treatment techniques, and laboratory experiments as well as linear plasma devices.  Apply advanced test and characterization techniques to also validate advanced materials for use as PFC.  Contribute to long-term activities in PWIE / FSD to mitigate limitations in PFCs currently available.  Materials from WP MAT and especially WP PRD that are envisioned for use in future relevant exposures e.g. DEMO Divertor / 1st Wall are studied  Link with activities related to neutron / proton exposure / self- damage testing when appropriate in a combination with plasma loading e.g. JULE-PSI.  Where appropriate, the manufacture of new and advanced materials can be funded in order to facilitate the link with WP MAT and existing advanced materials for use in DEMO, W7-X | | | |
| **Inputs required:**   * Advanced materials provided from WP MAT and WP PRD * Materials for the DEMO limiter via WP DIV * PWI / HHF parameters necessary for extrapolation to DEMO * Samples from WP TE/WP DIV/WP PRD | | | |
| **Tasks to be performed:**   * Plasma qualification of new materials (WPMAT) and components (WP DIV) for DEMO: Thermal shock and plasma synergistic loading of advanced material including exposures in Magnum-PSI (KIPT, DIFFER, FZJ) * Exposure of advanced materials e.g. Wf/W (WP PRD), SMART alloys (WP MAT), additively manufactured components (WP DIV) and others to heat loads and/or plasma loads for assessment of their PWI properties and exploration of limits of their application (FZJ, MPG) * Study of basic thermo-mechanical properties for advanced materials for divertor applications including reference material properties for comparison with neutron-irradiated sample in future (LPP-ERM/KMS, MPG)   + Establish experimental techniques   + Mechanical testing of W-yarns up to very high temperatures, subsequent microstructural characterization (link to neutron irradiation of W yearns & subsequent mechanical testing) (SCK-CEN as part of RU LPP-ERM/KMS)   + Establish experimental basis by e.g. self or proton damage (MPG, FZJ)   + Effect of fusion environment on the mechanical properties of W wire (MPG) * Exposure in plasma devices to study the interplay of recovery, recrystallization, plasma and ELM-like loading on surface cracking and fatigue lifetime (FZJ, KIPT, DIFFER) * Post-mortem analysis to characterize the induced surface and microstructure modifications as well as changes of the materials properties due to e.g. recrystallization behavior and/or surface morphology changes (FZJ, MPG) | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | **Deliverable ID** | **Deliverable Title** | | D001 | Analysis of Material behavior e.g. (Wf/W) under Plasma and heat loading regarding mechanical properties e.g. cracking, embrittlement, and microstructure. Link to SP A4 (FZJ) | | D002 | Performance of advanced materials under high heat loads and their microstructural characterization (MPG) | | D003 | Results from tests of small-scale samples of W and other advanced materials and components (LPP-ERM/KMS) | | D004 | Investigation of advanced materials under ELM-like/disruption transient loading and subsequent analysis (KIPT) | | D005 | Exposure of advanced materials in Magnum-PSI and subsequent analysis including thermal shock response of CVD-W to pulsed plasma (DIFFER) | | D006 | Effect of energetic ion irradiation on the strength of W wire (MPG) | | | | |
| **Management Information**  **Human Resources**:   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | J.W. Coenen | FZJ | 8 | D001 (M. Wirtz, J.W. Coenen, A. Litnovsky) | | T. Morgan | DIFFER | 3 | D005 | | I. Garkusha | KIPT | 15 | D004 | | D. Terentyev | LPP-ERM/KMS | 4 | D003 | | J. Riesch | MPG | 2.5 | D002, D006 (B. Curzadd, S. Elgeti) | | **Total** |  | 32.5 |  |   **Machine Resources:**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | PSI-2 | FZJ | 11 | D001 | | JUDITH | FZJ | 10 | D001 | | GLADIS | MPG | 4 | D002, D003, D006 | | Accelerator | MPG | 10 | D002, D003, D006 | | QSPA | KIPT | 5 | D004 | | MAGNUM-PSI | DIFFER | 4 | D005 |   **Other resources:**   * Use of irradiation facilities in SCK-CEN (LPP-ERM/KMS)   **Collaborations:**   * WP DIV, MAT, PRD in FTD   **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SPA Particle & Heat Load Studies in preparation of the exploitation of ITER and DEMO |  |  |
| **Task title:** | SP A.4 / High Temperature performance of Armour Materials: Recrystallization and Melting | **Task Ref. Nr.:** | PWIE-SP A.4.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  J.W. Coenen ( FZJ) | **Issue:** | 1 |
| **Local RO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer (PMU):** | David Douai (CO) | **Date:** | 22-Feb-2021 |
| **Reference Annual Workplan:** *will be added later* | | | |
| Melting and its effect on plasma performance and PFC lifetime in particular melting under relevant conditions or ITER and DEMO is still a partly unanswered issue. Here both, experiments in controlled environments and dedicated modelling shall be connected, e.g. by the code MEMOS-U.  The lifetime of PFUs for ITER / WEST is crucially linked to operation near and close to the point of recrystallization. Thus, the study of recrystallization in linear plasma devices including the role of the plasma composition shall be further explored.  Analysis of Tokamak exposed / molten, damaged tungsten materials  The issue of disruption loads on 1st wall tungsten-based materials, and Divertor components for ITER and DEMO is currently the limiting factor when talking about a viable fusion power plant. Here, experiments and the link to extrapotable modelling needs to be established | | | |
| **Inputs required:**   * Heat load specifications and experimental or theoretical data necessary to perform analysis and modelling * Materials or Monoblocks provided by the parties in line with Tasks * Advanced materials and composites where available see SP A3 * Experimental data from WP TE * Materials samples from SP A1 (e.g. recrystallization) | | | |
| **Tasks to be performed:**   * Characterization of microstructural changes caused by plasma exposure. Tungsten-based material exposed to different plasma conditions will be investigated in terms of mechanical and microstructural depth profiles. Heterogeneities will be traced in hardness and orientation maps and the locally dominating restauration mechanism identified. (DTU) * Tungsten material exposures in the QSPA under giant ELMs or disruptions with pronounced surface melting (KIPT). Characterization of dust in QSPA experiments: size analysis, influence of B field on trajectories. Stick effects at the surface. * Plasma heat loads which causes surface recrystallization and changes in Microstructure and melt threshold (QSPA/PSI-2/GLADIS) (KIPT, CEA, VR) * Assessment of effect of H and He on W recrystallization with links to WP TE (FZJ, DTU, CEA) * Joint activities with WP TE on damaged components (e.g. melting) (VR) * Experiments on Recrystallization in PSI-2 linked with SP A1 (FZJ, DTU) * Development of the MEMOS-U code Comprehensive validation activities. (link with WP TE (WEST, AUG) and SP B) (VR)   + Sensitivity of MEMOS-U to thermionic property uncertainties. Parametric simulation studies with MEMOS-U. Implementation of active cooling.   + Link to SP D (Plasma Background) * PFC heat load modelling and simulations of disruption mitigation (JSI) | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | **Deliverable ID** | **Deliverable Title** | | D001 | Assessment of hydrogen impact on material properties linked to ITER relevant PFUs (CEA) | | D002 | Annealing of chosen tungsten-based materials and quantification of recrystallization kinetics (DTU) | | D003 | Development and validation of the MEMOS-U code (link with WP TE – WEST/AUG) (VR) | | D004 | Code Development examine specific engineering use cases for transient heat flux analysis on ITER and/or DEMO (JSI) | | D005 | Influence of plasma pre irradiation with heat loads near surface recrystallization on surface damaging with heat loads above the melting threshold (KIPT) | | D006 | Analysis for PSI-2 exposed materials, focusing on recrystallization (FZJ) | | | | |
| **Management Information**  **Human Resources**:   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | M. Richou | CEA | 6 | D001 | | W. Pantleon | DTU | 5 | D002 | | S. Ratynskaia | VR | 6 | D003 (S.Ratynskaia, P.Tolias,L.Vignitchouk F.Castello ) | | S. Markelj | JSI | 3 | D004 (**L. Kos**, I.Vasileska,Leon Bogdanovic) | | I. Garkusha | KIPT | 15 | D005 | | M. Rasinski | FZJ | 2 | D006 ( M. Rasinski, A. Kreter, M. Vogel) | | **Total** |  | 37 |  |   **Machine Resources:**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | PSI-2 | FZJ | TBD[[1]](#footnote-1) | D006 | | GLADIS | MPG | TBD[[2]](#footnote-2) |  | | QSPA | KIPT | 5 | D005 |   **Other resources:**  **Collaborations:**   * IO ITPA DivSOL   **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP B / Experiments on erosion, deposition  and material migration |  |  |
| **Task title:** | SP B.1 Physics of erosion and deposition | **Task Ref. Nr.:** | PWIE-SP B.1.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  A. Hakola (VTT) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 20-Jan-2021 |
| **Reference Annual Workplan :** *will be added later* | | | |
| The Task will concentrate on broadening the understanding of physics behind erosion and (re-) deposition phenomena of plasma-facing materials and components in fusion-relevant conditions. To this end, experiments will be carried out in laboratory conditions and in linear plasma devices (MAGNUM-PSI, PSI-2, JULE-PSI, GyM) at varying plasma conditions including fluxes and fluence. The work will focus on assessing the erosion characteristics of different W-based materials and investigating the properties of re-deposited W with respect to bulk tungsten. Furthermore, physics questions related to arcing in material erosion and dust production will be experimentally addressed. Necessary materials for the implementation of the Task can be developed under SP B.4 and the obtained data will be used for benchmarking modelling efforts under SP D. Comparison with high-fluence exposures in tokamaks (WEST, AUG) will be carried out (with WP TE). | | | |
| **Inputs required:**   * Samples for reference and model systems (in collaboration with SP A, SP B.4, SP C) * Plasma exposure parameters relevant for ITER and DEMO exposure conditions | | | |
| **Tasks to be performed:**   * Determine the impact of plasma conditions on erosion of W model systems and formation of re-deposited layers: MAGNUM-PSI experiments and analyses (DIFFER) * Elucidate the sputtering properties of W model systems with varying morphologies in pure and mixed plasmas: GyM experiments and analyses (ENEA) * Assess the influence of evolving surface morphology on the sputtering properties of W model systems and formation of re-deposited layers: PSI-2 experiments and analyses. (SEM, LEIS, NRA, QMS) (FZJ) * Determine the sputtering properties, including angular distributions of sputtered particles, of W model systems with varying morphologies and re-deposited W layers: laboratory experiments and analyses (ÖAW) * Characterize surface erosion induced by hypervelocity W dust impacts: dust-gun experiments and analyses (ENEA) * Investigate the formation and properties of W and Be dust produced in off-normal (air and water leaks) conditions in fusion reactors (IAP) * Perform ion-beam analyses for samples from dust studies and laboratory experiments (VR - jointly with ENEA and ÖAW) | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | Deliverable ID: | Deliverable Title: | | D001 | Erosion rates of W model systems and composition and structure of re-deposited layers in MAGNUM-PSI at varying plasma conditions (DIFFER) | | D002 | Effective sputtering yields of W model systems with varying morphologies in pure and mixed plasmas in GyM and by hypervelocity dust impacts (ENEA) | | D003 | Erosion rates of W model systems with varying morphologies as well as composition and structure of re-deposited layers in PSI-2 at varying plasma conditions (FZJ) | | D004 | Effective sputtering yields of W model systems, including angular distributions of sputtered particles, and re-deposited W layers following exposure to controlled D and impurity ion beams (ÖAW) | | D005 | Size distribution and composition of Be and W dust formed during air and water leaks (IAP) | | D006 | RBS, ERDA and MEIS/LEIS characterization of selected samples from laboratory erosion and dust experiments (VR) | | | | |
| **Management Information**  **Human Resources**: *e.g. Person months - Professional Staff, Technical, Staff, Support Staff, Others*   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | T. Morgan | DIFFER | 4 | D001 (S. Brons, W. Melissen, T. Morgan, B. Tyburska-Pueschel) | | A. Uccello | ENEA | 4 | D002 (G. Alberti, M. De Angeli, A. Cremona, D. Dellasega, F. Ghezzi, M. Passoni, M. Pedroni, D. Ripamonti, A. Uccello) | | O. Marchuk | FZJ | 7 | D003 (P. Bittner, R. Koslowski, A. Kreter, O. Marchuk, M. Rasinski, M. Sackers) | | C. Lungu | IAP | 2 | D005 (T. Acsente, B. Butoi, G. Dinescu, P. Dinca, C. Lungu, C. Porosnicu, V. Satulu, C. Stancu) | | F. Aumayr | ÖAW | 5 | D004 (F. Aumayr, C. Cupak, P. Szabo) | | D. Primetzhofer | VR | 3 | D006 (L. Dittrich, M. Moro, P. Petersson, D. Primetzhofer, M. Rubel, J. Shams-Latifi, P. Ström) | | **Total** |  | 25 |  |   **Machine Resources: e.g. Linear devices type / days / HHF**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | MAGNUM-PSI | DIFFER | 4 | D001 | | GYM | ENEA | 15 | D002 | | PSI-2 | FZJ | 15 | D003 | | Accelerator | DIFFER | 3 | D001 | | Accelerator | FZJ | 3 | D003 | | Accelerator | VR | 5 | D006 | |  |  |  |  |   **Other resources:**  **Collaborations:**   * WP MAT, WP DIV, WP TE * ITPA DivSOL   **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP B / Experiments on erosion, deposition  and material migration |  |  |
| **Task title:** | SP B.2 Material migration in toroidal devices | **Task Ref. Nr.:** | PWIE-SP B.2.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  A. Hakola (VTT) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 20-Jan-2021 |
| **Reference Annual Workplan:** *will be added later* | | | |
| Material migration, both resulting from erosion of plasma-facing components and of plasma impurities, will be investigated in selected, ITER- and DEMO-relevant experiments in the EUROfusion tokamaks, in particular in ASDEX Upgrade and WEST, as well as in the W7-X stellarator. The main tools will be exposure of samples with marker layers or injection of tracer elements into the fusion plasma during a series of pre-determined plasma discharges. The experiments will be done in collaboration with WP TE and WP W7X or internal programmes of the involved machines. The role of WP PWIE is to procure materials or produce marker samples for the experiments, make the necessary pre- and post-exposure characterisation of samples, as well as provide data on component erosion, migration patterns of the different elements, and composition of re-deposited layers for modelling efforts under SP D. At the focus will be identifying the balance between gross and net erosion of W in fusion plasmas, migration of W and impurities like N, Ne, Ar in the SOL, and investigating the properties of re-deposited W layers with respect to virgin W components. Work related to JET-ILW will be done in SP D (modelling) and SP E (surface analyses). The studies include using isotopes such as 13C or 15N. | | | |
| **Inputs required:**   * Experimental programme for plasma experiments in WP TE * Availability of erosion/migration samples for analyses - jointly with WP TE, WP W7X, and AUG, WEST, and W7-X teams * Plasma background and erosion/migration modelling results from SP D | | | |
| **Tasks to be performed:**   * Determine erosion, re-deposition, and fuel-retention patterns on WEST PFUs after C3, C4, and C5 campaigns: project coordination and surface analyses, including melting patterns for SP A (CEA) * Determine influence of surface morphology on erosion and re-deposition patterns of marker samples and coatings (AUG, WEST): project coordination as well as broad-beam and microbeam RBS/NRA (JSI) * Determine gross and net erosion of marker samples and coatings (AUG, WEST) and migration of impurities in edge plasmas (AUG, WEST, W7-X): project coordination and surface analyses (VTT) * Coordinate erosion and migration experiments and related surface analyses on W7-X; perform surface analyses for erosion/deposition, fuel-retention, and surface-modification patterns (incl. melting patterns for SP A) on samples from AUG, WEST, and W7-X (FZJ). * Coordinate erosion and migration experiments and related surface analyses on AUG and perform surface analyses for erosion/deposition, fuel-retention, and surface-modification patterns (incl. melting patterns for SP A) on samples from AUG (MPG) * Perform surface analyses for erosion/deposition, fuel-retention, and surface-modification patterns on samples from W7-X (MPG) * Perform surface analyses for erosion/deposition, fuel-retention, and surface-modification patterns on samples from WEST (MPG) * Perform detailed surface analyses for fuel-retention and impurity-deposition patterns on marker samples and other samples from specific plasma experiments (AUG, WEST, W7-X) (VR) * Microscopy studies of marker samples and other samples from specific plasma experiments (AUG, WEST, W7-X) (IPP\_LM - jointly with FZJ and MPG) * Ion-beam measurements (broad-beam and microbeam) of marker samples and other samples from specific plasma experiments (AUG, WEST, W7-X), comparison to linear devices and lab experiments (RBI) | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | Deliverable ID: | Deliverable Title: | | D001 | Erosion, re-deposition, and fuel-retention patterns on selected WEST PFUs after C3, C4, and C5 campaigns (CEA) | | D002 | Erosion and re-deposition rates as a function of surface roughness/morphology changes in controlled L- and H-mode plasma experiments (JSI) | | D003 | Balance between gross and net erosion of plasma-facing materials in controlled L- and H-mode plasma experiments (VTT) | | D004 | NRA, SEM, and FIB characterization of marker samples and coatings from selected plasma experiments on AUG, WEST, and W7-X with conclusions (FZJ) | | D005 | RBS, NRA, SEM, and CLSM characterization of marker samples and coatings from selected plasma experiments on AUG with conclusions (MPG) | | D006 | RBS, NRA, SEM, and CLSM characterization of marker samples and coatings from selected plasma experiments on W7-X with conclusions (MPG) | | D007 | RBS, NRA, SEM, and CLSM characterization of marker samples and coatings from selected plasma experiments on WEST with conclusions (MPG) | | D008 | RBS, NRA, ERDA, and MEIS/LEIS characterization of marker samples and coatings from selected plasma experiments on AUG, WEST, and W7-X with conclusions (VR) | | D009 | SEM, TEM and FIB characterization of selected samples from experiments on AUG, WEST, and W7-X (IPP\_LM) | | D010 | ERDA, RBS, NRA and PIXE characterization of selected samples from experiments on AUG, WEST, and W7-X as well from laboratory and linear plasma experiments (RBI) | | | | |
| **Management Information**  **Human Resources**: *e.g. Person months - Professional Staff, Technical, Staff, Support Staff, Others*   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | M. Diez | CEA | 2 | D001 (T. Angot, R. Bisson, M. Diez, G. Giacometti, M. Minissale, C. Pardanaud, …) | | M. Rasinski | FZJ | 2 | D004 (T. Dittmar, S. Moeller, J. Oelmann, M. Rasinski, G. Sergienko) | | E. Fortuna-Zalesna | IPPLM | 2 | D009 (P. Bazarnik, E. Fortuna-Zalesna, T. Plocinski, M. Spychalski, S. Szpilewicz, J. Zdunek, W. Zielinski) | | S. Markelj | JSI | 3 | D002 (M. Kelemen, S. Markelj, E. Punzon-Quijorna, P. Pelicon) | | K. Krieger | MPG | 2 | D005 (M. Balden, S. Elgeti, K. Hunger, W. Jacob, K. Krieger, M. Mayer) | | M. Mayer | MPG | 2 | D006 (M. Balden, C. P. Dhard, S. Elgeti, K. Hunger, W. Jacob, K. Krieger, M. Mayer) | | M. Balden | MPG | 2 | D007 (M. Balden, S. Elgeti, K. Hunger, W. Jacob, K. Krieger, M. Mayer) | | I. Bogdanovic Radovic | RBI | 3 | D010 (I. Bogdanović Radović, S. Fazinić, Z. Siketić, T. Tadić) | | P. Petersson | VR | 2 | D008 (L. Dittrich, M. Moro, P. Petersson, D. Primetzhofer, M. Rubel, J. Shams-Latifi, P. Ström) | | A. Hakola | VTT | 2 | D003 (A. Hakola, P. Jalkanen, J. Likonen, K. Mizohata, T. Vuoriheimo) | | **Total** |  | 22 |  |   **Machine Resources: e.g. Linear devices type / days / HHF**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | Accelerator | FZJ | 3 | D004 | | Accelerator | JSI | 5 | D002 | | Accelerator | MPG | 8 | D005, D006, D007 | | Accelerator | RBI | 5 | D010 | | Accelerator | VR | 5 | D008 | | Accelerator | VTT | 2 | D003 | |  |  |  |  |   **Other resources:**  **Collaborations:**   * WP TE (AUG, WEST; including internal programmes) * WP W7X * ITPA DiVSOL   **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP B / Experiments on erosion, deposition  and material migration |  |  |
| **Task title:** | SP B.3 Characterization of plasma-exposed materials | **Task Ref. Nr.:** | PWIE-SP B.3.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  A. Hakola (VTT) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 20-Jan-2021 |
| **Reference Annual Workplan:** *will be added later* | | | |
| The goal of SP B.3 is to carry out post exposure analyses for selected wall tiles and samples, extracted from EUROfusion devices after exposure to extended plasma operations (e.g., experimental campaigns in toroidal devices) or SP B relevant experiments other than those listed in Task SP B.2. The devices involved will be ASDEX Upgrade, WEST, and W7-X but also individual samples from other (linear plasma) devices can be characterized for supporting the overall objectives of SP B. The main interests will be identifying changes in the surface characteristics of the analysed components as well as determining their erosion, deposition, and fuel-retention patterns. In addition, the obtained results are expected to provide deeper insights on the arcing behaviour of plasma-facing components and mechanisms of dust production in toroidal devices. | | | |
| **Inputs required:**   * Experimental programme for plasma experiments in WP TE * Wall tiles and components removed for post-exposure analyses from AUG, WEST, and W7-X * Samples produced for plasma experiments on AUG, WEST, and W7-X | | | |
| **Tasks to be performed:**   * Carry out post-exposure analyses of selected PFUs from WEST Phase 1 and pre-characterize selected PFUs for Phase 2: project coordination and surface analyses (CEA) * Project coordination for W7-X analyses; Determine surface changes on selected WEST and W7-X wall tiles, reference coatings from plasma exposures in PSI-2, and from recrystallization studies under SP A in MAGNUM-PSI (FZJ) * Determine surface changes on selected WEST PFUs and reference coatings from plasma exposures in MAGNUM-PSI, PSI-2, and GyM (IPP\_LM) * Determine erosion, deposition, and fuel retention profiles on selected WEST PFUs and reference coatings from plasma exposures in MAGNUM-PSI, PSI-2 and GyM (IST) * Determine erosion, deposition, and fuel retention profiles on selected AUG and WEST wall tiles (JSI) * Project coordination for AUG analyses; Determine surface changes as well as erosion, deposition, and fuel retention profiles on selected AUG, WEST, and W7-X wall tiles and other components as well as samples from recrystallization studies under SP A in MAGNUM-PSI (MPG) * Determine composition and surface structure of reference coatings and test coatings from plasma exposures in MAGNUM-PSI, PSI-2 and GyM (NCSRD) * Determine erosion, deposition, and fuel retention profiles on selected AUG, WEST and W7-X wall tiles as well as reference coatings from plasma exposures in MAGNUM-PSI, PSI-2 and GyM (VTT) | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | Deliverable ID: | Deliverable Title: | | D001 | Database on ageing, erosion, and fuel-retention behavior of selected WEST PFUs (CEA) | | D002 | SEM, FIB, NRA, and LIBS characterization of selected WEST and W7-X wall tiles and plasma-exposed reference samples (FZJ) | | D003 | SEM, TEM and FIB characterization of selected WEST PFUs and plasma-exposed reference samples (IPPLM) | | D004 | RBS and NRA characterization of selected WEST PFUs and plasma-exposed reference samples (IST) | | D005 | Surface analyses of selected AUG and WEST wall tiles (JSI) | | D006 | RBS, NRA, SEM, and CLSM characterization of selected AUG, WEST, and W7-X wall tiles and components as well as samples from MAGNUM-PSI (MPG) | | D007 | RBS, SEM, XRD and XRF characterization of selected Be reference coatings and plasma-exposed samples (NCSRD) | | D008 | RBS, NRA, ERDA, LIBS, and SIMS characterization of selected AUG, WEST and W7-X wall tiles and plasma-exposed reference samples (VTT) |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | | **Management Information**  **Human Resources**: *e.g. Person months - Professional Staff, Technical, Staff, Support Staff, Others*   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | M. Diez | CEA | 2 | D001 (T. Angot, R. Bisson, M. Diez, G. Giacometti, M. Minissale, C. Pardanaud,…) | | M. Rasinski | FZJ | 2 | D002 (S. Moeller, J. Oelmann, M. Rasinski, G. Sergienko) | | E. Fortuna-Zalesna | IPPLM | 3 | D003 (P. Bazarnik, E. Fortuna-Zalesna, T. Plocinski, M. Spychalski, S. Szpilewicz, J. Zdunek, W. Zielinski) | | E. Alves | IST | 2 | D004 (E. Alves, N. Catarino, R. Mateus, R. Silva) | | M. Panjan | JSI | 1 | D005 (M. Kelemen, M. Panjan) | | M.. Mayer | MPG | 5 | D006 (M. Balden, C. P. Dhard, S. Elgeti, W. Jacob, K. Krieger, M. Mayer) | | K. Mergia | NCSRD | 2 | D007 (M. Axiotis, S. Dellis, A. Lagoyannis, E. Manios, K. Mergia, P. Tsavalas) | | A. Hakola | VTT | 2 | D008 (A. Hakola, P. Jalkanen, J. Likonen, K. Mizohata, T. Vuoriheimo) | | **Total** |  | 20 |  |   **Hardware/ Machine Resources: e.g. Materials / Linear devices type / days / HHF**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | Accelerator | IST | 5 | D004 | | Accelerator | MPG | 7 | D007 | | Accelerator | NCSRD | 5 | D006 | | Accelerator | VTT | 2 | D010 | | Accelerator | FZJ | 1 | D002 | |  |  |  |  |   **Other resources:**  **Collaborations:**   * WP TE (AUG, WEST; including internal programmes) * WP W7X   **Other information:**   * Connected to TSVVs associated with WP PWIE | | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP B / Experiments on erosion, deposition  and material migration |  |  |
| **Task title:** | SP B.4 Reference coatings for ITER and DEMO | **Task Ref. Nr.:** | PWIE-SP B.4.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  A. Hakola (VTT) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 20-Jan-2021 |
| **Reference Annual Workplan:** *will be added later* | | | |
| The overall objective of the Task is to produce and characterize reference coatings and test components such that they could simulate the re-deposited layers observed in fusion devices and to investigate the role of different production parameters on their structure, composition, impurity contend, and erosion and retention characteristics. In addition, a separate activity will be production of marker layers for experiments under SP B if development work is needed in the production phase. Once recipes for depositing layers are in an advanced state, samples for experiments in SP A, SP C, SP E, and SP X can be produced upon request. | | | |
| **Inputs required:**   * Table of requirements for the properties of the reference samples - jointly with SP A, SP C, SP D, SP E and SP X * Deposition systems available for WP PWIE | | | |
| **Tasks to be performed:**   * Production and characterization of W reference coatings, multilayer structures, and proxies for re-deposited layers with varying composition, morphology, and grain structure (ENEA) * Production and characterization of Be reference coatings with varying composition, morphology, and grain structure (IAP) * Production and characterization of W reference coatings and proxies for re-deposited layers with varying composition, morphology, and grain structure (IAP) * Chemical and microstructural characterization of the produced Be and W reference layers (CEA) * Compositional and microstructural characterization of the produced W reference layers (CIEMAT) * Compositional characterization of the produced Be and W reference layers (IST) * Identifying fuel-retention properties of the produced Be and W reference layers (JSI) * Compositional characterization (broad-beam and microbeam) of the produced Be and W reference layers (RBI) * Identifying elemental composition at different depths throughout the produced Be and W reference layers (VTT) | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | Deliverable ID: | Deliverable Title: | | D001 | W-based coatings with pre-defined properties (incl. SEM, AFM, TDS characterization) produced for analyses and plasma experiments (ENEA) | | D002 | Be and W-based coatings with pre-defined properties (incl. SEM, XRD, GDOES, TDS characterization) produced for analyses and plasma experiments (IAP) | | D003 | Raman, SEM, and CLSM characterization of selected Be and W reference samples (CEA) | | D004 | SEM and SIMS characterization of selected W reference samples (CIEMAT) | | D005 | RBS and NRA characterization of selected Be and W reference samples (IST) | | D006 | TDS, XPS, and XRD characterization of selected Be and W reference samples (JSI) | | D007 | ERDA and PIXE characterization of selected Be and W reference samples (RBI) | | D008 | RBS, NRA, ERDA, LIBS, and SIMS characterization of selected Be and W reference samples (VTT) | | | | |
| **Management Information**  **Human Resources**:; *e.g. Person months - Professional Staff, Technical, Staff, Support Staff, Others*   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | C. Pardanaud | CEA | 2 | D003 (T. Angot, R. Bisson, G. Giacometti, M. Minissale, C. Pardanaud,…) | | D. Alegre | CIEMAT | 3 | D004 (D. Alegre, A. de Castro, F. Tabares, M. Gonzalez Viada) | | M. Passoni | ENEA | 3 | D001 (G. Alberti, D. Dellasega, L. Laguardia, M. Passoni, M. Pedroni, A. Uccello, E. Vassallo) | | C. Porosnicu | IAP | 9 | D002 (F. Baiasu, B. Butoi, S. Cornel, P. Dinca, M. Gherendi, E. Grigore, S. Ion, C. Lungu, S. Parlog, O. Pompilian, C. Porosnicu, C. Ruset, Z. Valer) | | E. Alves | IST | 2 | D005 (E. Alves, N. Catarino, R. Mateus, R. Silva) | | V. Nemanic | JSI | 3 | D006 (V. Nemanic, M. Zumer (TDS), J. Zavasnik (XPS, XRD)) | | I. Bogdanovic Radovic | RBI | 2 | D007 (I. Bogdanović Radović, S. Fazinić, Z. Siketić, T. Tadić) | | A. Hakola | VTT | 2 | D008 (A. Hakola, P. Jalkanen, J. Likonen, K. Mizohata, T. Vuoriheimo) | | **Total** |  | 25 |  |   **Hardware/ Machine Resources: e.g. Materials / Linear devices type / days / HHF**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | Accelerator | IST | 5 | D005 | | Accelerator | RBI | 5 | D007 | | Accelerator | VTT | 1 | D008 | |  |  |  |  |   **Other resources:**   * Travel: Participation of members from CU and UT in LIBS measurements of Be samples at VTT   **Collaborations:**   * IO and ITPA DivSOL   **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP C / Retention and Release |  |  |
| **Task title:** | SP C.1 Transport of Hydrogen through the first wall of fusion devices | **Task Ref. Nr.:** | PWIE-SP C.1.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  K. Schmid (FZJ) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 20-Jan-2021 |
| **Reference Annual Workplan 2021:** *will be added later* | | | |
| The transport of hydrogen isotopes HIs through the first wall of fusion devices is the driving process for HIs retention but also for permeation to the coolant. Both of these processes have fundamental implications for the safety and the tritium self-sufficiency of a fusion reactor. The first wall of a future fusion reactor will be comprised of the top armor material W and structural materials below like steel or Cu alloys that connect the top plasma-facing surface to the coolant. Therefore, the transport through the whole component from the W armor layer to the coolant needs to be understood. This firstly requires experiments on HIs retention in the different materials (W, steels and Cu-alloys) by trapping at intrinsic defects and at defects generated due to exposure to the fusion environment: bombardment by plasma species and/or MeV neutrons, formation of transmutation and decay products like e.g.: Re and He. Secondly experiments on permeation across the interface in between the materials are required that determine the barrier properties of the different interfaces and the influence of typical impurities like O on these properties. Finally, the transition from the metal coolant pipe into the coolant water needs to be understood to provide the dependence of the dissolution of HIs from the metal into the water as function of temperature, pH-value and pressure.  The experiments on HIs retention in the materials will allow making predictions about the loss of Tritium fuel species in the wall and the experiments on HIs transport will allow making predictions about the amount of Tritium recoverable through the coolant water. | | | |
| **Inputs required:**   * Facilities: MAGNUM, PSI-2, Accelerators | | | |
| **Tasks to be performed 2021:**   * Study the effect of O or C layers on D: bulk vs surface uptake - from 1 monolayer to a few hundred of nanometers (CEA) * Study the effect of C layers on D: bulk vs surface uptake - from 1 monolayer to a few hundred of nanometers (CEA) * Permeation (D) through Gas/Gas interfaces with interface characterization (CEA) * Dynamic measurements of deuterium retention and isotope exchange in W (DIFFER) * Influence of ELMs on deuterium retention and outgassing in W (DIFFER) * Gas driven permeation through and retention in W, Steel, W on Steel and W on Cu (FZJ) * Measurement and modelling of Ion Driven Permeation in W, Cu and Fe-Ni alloys "heavy alloys" (MPG) * Compare D permeation through W with D atoms and 300 eV/D ions (JSI, MPG) * FIB/SEM/EDX analysis of material interfaces in multi material permeation samples (IPP\_LM) * Permeation barrier properties of chromia grown on dense Cr films on Eurofer (JSI) * Studying the influence of (re-deposited) W on EUROFER on D retention (OEAW, VR)   **Tasks to be performed 2022:**   * Permeation (D,T) through Liquid/Solid interfaces with interface characterization (CEA) | | | |
| **Deliverables 2021:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | Deliverable ID: | Deliverable Title: | | D001 | CEA: Uptake of D as function of O layer thickness in bulk and surface | | D002 | CEA: Uptake of D as function of C layer thickness in bulk and surface | | D003 | CEA: Preparation experiment with D for Gas/Gas permeation | | D004 | DIFFER: D concentration in the surface as function of temperature and plasma flux | | D005 | DIFFER: Compare hydrogen loading efficiency of plasma vs laser-based ELM simulation | | D006 | FZJ: Comparison of permeability W/Cu W/CuCrZ W/Steel vs pure substrates | | D007 | MPG: Permeability during ion beam permeation of W, Cu and heavy-alloys as function of temperature | | D008,D009 | JSI, MPG: Permeated amount of D for atom and ion beam loading as function of temperature | | D010 | IPP\_LM: FIB/SEM/EDX analysis of multi material permeation samples (Samples from MPG, JSI) | | D011 | JSI: Permeation reduction factor of Chromia of Cr films on Eurofer | | D012,D013 | OEAW, VR: D retention as function of flunence in "re-deposited" W on EUROFER |   **Deliverables 2022:**   |  |  | | --- | --- | | D003 | CEA: T-permeation experiment Gas/Gas compared to Gas/Water | | | | |
| **Management Information**  **Human Resources**: 2021 *e.g. Person months – Professional Staff, Technical, Staff, Support Staff, Others*   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | R. Bisson | CEA | 8 | D001, D002 | | E. Bernard | CEA | 2 | D003 | | T. Morgan | DIFFER | 4 | D004, D005 | | A. Houben | FZJ | 11 | D006, D005 | | A. Manhard | MPG | 2 | D007 | | S. Markelj | JSI | 3 | D008 | | T. Schwarz-Selinger | MPG | 2 | D009 | | L.Ciupinski | IPP\_LM | 4 | D010 | | V: Nemanic | JSI | 4 | D011 | | F. Aumayer | OEAW | 3 | D012 | | D. Primetzhofer | VR | 3 | D013 | | **Total** |  | 46 |  |   **Human Resources**: 2022 *e.g. Person months – Professional Staff, Technical, Staff, Support Staff, Others*   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | E. Bernard | CEA | 12 | D003 |   **Hardware/ Machine Resources: e.g. Materials / Linear devices type / days / HHF**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | MAGNUM | DIFFER | 4 | D005 | | Accelerator | DIFFER | 8 | D004, D005 | | UPP | DIFFER | 8 | D004 | | Accelerator | JSI | 7 | D008 | | Accelerator | MPG | 2 | D009 | |  |  |  |  |   **Other resources:**    **Travel:**  **Collaborations:**  **WP-BB, WP-SAI**  **Other information:**  **Connected to TSVVs associated with WP PWIE** | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP C / Retention and Release |  |  |
| **Task title:** | SP C.2 Modelling of Hydrogen Transport properties in the first wall | **Task Ref. Nr.:** | PWIE-SP C.2.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  K. Schmid (FZJ) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 20-Jan-2021 |
| **Reference Annual Workplan:** *will be added later* | | | |
| The transport of hydrogen isotopes (His) through the first wall of fusion devices is the driving process for HIs retention but also for permeation to the coolant. Both of these processes have fundamental implications for the safety and the tritium self-sufficiency of a fusion reactor. The first wall of a future fusion reactor will be comprised of the top armor material W and structural materials below like steel or Cu alloys that connect the top plasma-facing surface to the coolant. Modeling this transport is multi-scale problem that requires both macroscopic rate equation models like Diffusion Trapping Codes (DTCs) and atomistic models like Density Functional Theory (DFT). The DFT codes model the energy landscapes around lattice imperfections, which then yield the activation energies and attempt frequencies for the DTCs that can then model the transport within an entire first wall component on realistic time scales. The macroscopy rate equation models need to able to handle the interfaces between different wall materials, temperature gradients and appropriate boundary conditions on the plasma and coolant water side to describe the entry of HIs into and out of the first wall. To model the retention in the material the codes have to contain models that describe the defect evolution due to interaction of the first wall with the fusion environment: bombardment by plasma species and/or MeV neutrons, formation of transmutation and decay products like e.g. Re and He. | | | |
| **Inputs required:**   * Experimental data from permeation and retention experiments | | | |
| **Tasks to be performed:**   * DFT Calculation of H on top of WO (CEA) * H diffusion and segregation at the Cu/W interface (CEA) * DFT calculations of defects in W in the presence of H (UKAEA) | | | |
| **Deliverables :** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | **Deliverable ID** | **Deliverable Title** | | D001 | Energy barriers for H to transition into the bulk (CEA) | | D002 | Energy landscape of H at a W/Cu material interface (CEA) | | D003 | Stress and strain as function of defect concentration and H amount | | | | |
| **Management Information**  **Human Resources**:   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | Y. Ferro | CEA | 9 | D001, D002 | | M. Lavrentiev | UKAEA | 6 | D003 | | **Total** |  | 15 |  |   **Hardware/ Machine Resources:**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | **n.a.** |  |  |  |   **Other resources:**  **Collaborations:**  **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP C / Retention and Release |  |  |
| **Task title:** | SP C.3 Influence of He, high-flux D and impurities on Hydrogen retention and transport | **Task Ref. Nr.:** | PWIE-SP C.3.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  K. Schmid (FZJ) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 20-Jan-2021 |
| **Reference Annual Workplan:** *will be added later* | | | |
| The transport of hydrogen isotopes HIs through the first wall of fusion devices is the driving process for HIs retention but also for permeation to the coolant. Both of these processes have fundamental implications for the safety and the tritium self-sufficiency of a fusion reactor. This requires experiments on HIs retention in the different materials (W, steels and Cu-alloys) due to trapping at intrinsic defects and at defects generated due to exposure to the fusion environment: bombardment by plasma species (HIs and impurities) and accumulation of He due to nuclear reactions. He forms clusters and bubbles in metals which act as strong traps for HIs, and thus can lead to a high Tritium inventory. Experiments on the dependence of He-clustering and bubble formation on the local He amount and temperature history of the material must be performed and the binding energy of HIs to these defects must be measured. Also, synergistic effects due to the simultaneous presence of HIs and He like stabilization of the generated defects need to be investigated. | | | |
| **Inputs required:**   * Facilities: Accelerators | | | |
| **Tasks to be performed:**   * Reduction and removal of surface oxide films from W by deuterium plasma (MPG) * Influence of surface oxide films on the uptake of deuterium into the metallic tungsten in dependence of the oxide film thickness (MPG) * Influence of surface oxide films on the release of deuterium into the metallic tungsten in dependence of the oxide film thickness (MPG) * XRD and Raman of Oxide films on W in cooperation with MPG (JSI, MPG) * Comparing He cluster nucleation in defect free and e-beam-damaged W (MPG) * E-beam irradiation of single crystal W from MPG (ENEA) * Influence of surface microstructure due to low energy He irradiation on D uptake studied in situ (JSI, MG) * Self-damaged W samples for JSI investigation (MPG) | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | **Deliverable ID** | **Deliverable Title** | | D001,D004 | Removal rate of Wox layers as function of temperature (MPG, JSI) | | D002,D005 | Uptake of D through oxide films as function of temperature and thickness (MPG, JSI) | | D003,D006 | Release of D through oxide films from the W bulk as function of temperature and thickness (MPG, JSI) | | D007,D009 | Difference in He retention in defect free and e-beam damaged W (MPG, ENEA) | | D008,D010 | Influence of near surface He implantation on D release (JSI) | | | | |
| **Management Information**  **Human Resources**:   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | K. Kremer | MPG | 8 | D001, D002, D003 | | J. Zavaznik | JSI | 2 | D004, D005, D006 | | T. Schwarz-Selinger | MPG | 5 | D007, D7008 | | M. Vadrucci | ENEA | 3 | D009 | | S. Markelj | JSI | 5 | D010 | | **Total** |  | 23 |  |   **Hardware/ Machine Resources:**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | Accelerator | MPG | 25 | D001, D002, D003 D008 | | Accelerator | JSI | 8 | D010 |   **Other resources:**    **Collaborations:**  **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP C / Retention and Release |  |  |
| **Task title:** | SP C.4 Influence of n-damage on Hydrogen retention and transport | **Task Ref. Nr.:** | PWIE-SP C.4.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  K. Schmid (FZJ) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 20-Jan-2021 |
| **Reference Annual Workplan:** *will be added later* | | | |
| The transport of hydrogen isotopes HIs through the first wall of fusion devices is the driving process for HIs retention but also for permeation to the coolant. Both of these processes have fundamental implications for the safety and the tritium self-sufficiency of a fusion reactor. This requires experiments on HIs retention in the different materials (W, steels and Cu-alloys) by trapping at intrinsic defects and at defects generated by the bombardment with MeV neutrons from the fusion reaction. Since MeV fusion neutrons are not available at high fluxes, their effect in the materials will have to be mimicked either by high-energy ion implantation or by exposure to fission neutrons. In the past experiments with self-damaged W have shown that the simultaneous presence of HIs increase the damage produces by self-implantation. These studies need to be continued and extended to other fusion relevant materials like steels and Cu-alloys. | | | |
| **Inputs required:**   * FZJ accelerator facilities | | | |
| **Tasks to be performed:**   * Impact of irradiation damage on hydrogen permeation and hydrogen and helium retention | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | Deliverable ID: | Deliverable Title: | | D001 | Influence of transmutation products produced by 30MeV p-irradiation on retention in W (FZJ) | | | | |
| **Management Information**  **Human Resources**:   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | S. Möller | FZJ | 3 | D001 (S. Möller, R. Rayaprolu, ...) | | **Total** |  | 3 |  |   **Hardware/ Machine Resources:**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | PSI-2 | FZJ | 5 | D1 |   **Other resources:**  **Collaborations:**   * FTD and WP MAT   **Other information:** | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP D / PSI and SOL Modelling |  |  |
| **Task title:** | SP D.1 Plasma Boundary Modelling | **Task Ref. Nr.:** | PWIE-SP D.1.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  A. Kirschner (FZJ) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 26-Feb-2021 |
| **Reference Annual Workplan:** *will be added later* | | | |
| Plasma modelling activities focus on the production of background plasma parameters, which are needed as input for migration modelling. This includes 1D, 2D and 3D modelling of specific experiments (e.g. the tokamaks AUG, JET-ILW, WEST, the stellarator W7-X and linear devices like MAGNUM-PSI, PSI-2 or GyM) and also predictive studies (e.g. for ITER, DEMO or the linear device JULE-PSI). Besides modelling of "volumetric" plasma parameters such as temperature, density and flow velocity also near surface parameters considering the detailed sheath characteristics in front of surfaces are considered The plasma conditions can cover inter- and intra-ELM phases, ELM-averaged and detached conditions. Turbulence processes can be considered. The modelling should consider H, D, T plasmas including seeding species, further impurities from wall erosion and helium.  Plasma codes like SOLEDGE3X-EIRENE, SOLPS, EMC3-EIRENE, EDGE2D-EIRENE and PIC-based codes can be applied to address the modelling of plasma background parameters. | | | |
| **Inputs required:**   * Experimental plasma parameters to be provided by WEST, MAGNUM, GyM, W7-X, AUG, JET-ILW, PSI-2 and SP X. Tokamak information from WP TE and WP JET and stellarator from WP W7X. | | | |
| **Tasks to be performed:**   * Modelling (SOLEDGE3X-EIRENE) of background plasmas to be used as input for migration modelling: WEST (CEA) * Modelling (SOLPS-ITER) of background plasmas to be used as input for migration modelling: linear devices (DIFFER) * Modelling (SOLPS-ITER) of background plasmas to be used as input for migration modelling: GyM (ENEA) * Modelling (EMC3-EIRENE) of background plasmas to be used as input for migration modelling: W7-X and PSI-2 (FZJ) * PIC modelling of collisional sheath (IPP.CR) * PIC modelling for emissive sheath at hot surfaces (VR) * Modelling (e.g. SOLPS-ITER or EDGE2D-EIRENE) of background plasmas to be used as input for migration modelling: AUG, JET-ILW (VTT) | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | **Deliverable ID** | **Deliverable Title** | | D001 | Plasma background parameters of WEST for modelling of impurity migration experiments (focus on He and D discharges) (CEA) | | D002 | Plasma background parameters of linear devices (in particular MAGNUM-PSI) for modelling of impurity migration experiments (DIFFER) | | D003 | Plasma background parameters of GyM for modelling of impurity migration experiments (ENEA) | | D004 | Plasma background parameters of W7-X for modelling of impurity migration experiments as well as PSI-2 (FZJ) | | D005 | Characterization of the emissive and collisional plasma sheath (considering ELMy discharges, rough surfaces, DT plasma) (FZJ) | | D006 | Semi-empirical analytic expressions of emitted current escaping form tungsten surfaces (inter- and intra-ELM conditions) (VR) | | D007 | Plasma background parameters of AUG and JET-ILW for modelling of impurity migration experiments (VTT) | | | | |
| **Management Information**  **Human Resources**:   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | G. Ciraolo | CEA | 2 | D001 (GY. Marandet, NN) | | E. Westerhof | DIFFER | 2 | D002 (E. Westerhof, J. Gonzalez- Munoz) | | M. Passoni | ENEA | 2 | D003 (M. Passoni, E. Tonello) | | S. Xu | FZJ | 4 | D004 (S. Xu, NN) | | D. Tskhakaya | IPP.CR | 5 | D005 (D. Tskhakaya, M. Komm, A. Podolnik) | | S. Ratynskaia | VR | 4 | D006 (S. Ratynskaia, P. Tolias) | | M. Groth | VTT | 3 | D007 (M. Groth, A. Järvinen, H. Kumpulainen) | | **Total** |  | 22 |  |   **Hardware/ Machine Resources:**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | n.a. |  |  |  |   **Other resources:**   * HPC requests   **Collaborations:**   * WP TE, internal program of WP W7X, AUG, and WP JET * IO and ITPA DivSOL   **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP D / PSI and SOL Modelling |  |  |
| **Task title:** | SP D.2 Production of Atomic/Molecular and Surface Data | **Task Ref. Nr.:** | PWIE-SP D.2.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  A. Kirschner (FZJ) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 26-Feb-2021 |
| **Reference Annual Workplan :** *will be added later* | | | |
| This subproject contains the calculation of rate coefficients for ionization, dissociation, recombination and excitation of atoms and molecules under fusion-relevant plasma conditions. This includes atomic and molecular species of H, D, T as well as helium and seeding gases and also elements as result of wall erosion (W, Be, steel). Moreover, molecules containing Be/H and W/H are considered.  The generation of surface data includes erosion yields and reflection coefficients, also considering morphology effects, mixing of materials and redeposited layers. The output also should provide angular and energy information of the eroded and reflected species. The study of dust formation (e.g. via arcing or melting mechanisms, clustering) is also envisaged. Possible tools are based for instance on Molecular Dynamics or the Binary Collision Approximation. | | | |
| **Inputs required:**   * Experimental data for comparison if applicable (e.g. data from other WP PWIE SPs: SP A, SP B, SP E, SP X) | | | |
| **Tasks to be performed:**   * Development of dust formation models (CEA) * Production of atomic/molecular data for EIRENE (FZJ) * Calculation of rate coefficients for ionization/excitation, MD simulations (ÖAW) * SDTrimSP related modelling of erosion including morphology, roughness, fuzz (ÖAW) * Model development for production mechanisms for dust formation from melting (VR) * Production of erosion yields for redeposited W in comparison to bulk W (VTT) * Development of machine learning for interatomic W potentials (VTT) * Production of erosion yields and reflection coefficients for rough W surfaces (VTT) * Upgrade of AM database and CRM for molecules (VTT) * SDTrimSP-3D based erosion modelling considering roughness, morphology (MPG) | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | **Deliverable ID** | **Deliverable Title** | | D001 | Dust production model for anomalous events and detached conditions (CEA) | | D002 | Rate coefficients for atomic/molecular process for detached conditions (FZJ) | | D003 | D3.1: Effect of seeding projectiles (e.g. Ar, Kr) on tungsten sputtering / D3.1; Electron impact cross sections (ionization, excitation), D3.3 Combine BCA and MD at transition from low energies to BCA limit (OAEW) | | D004 | Erosion information of surfaces including morphology, roughness, fuzz (OAEW) | | D005 | Model for dust production from melting; prediction of dust formation from molten metal, droplet ejection (VR) | | D006 | D5.1 Erosion and retention properties of redeposited tungsten, D5.2 Interaction potential of tungsten to be used for sputtering/reflection modelling / D5.3 Sputtering and reflection yields for various kinds of tungsten morphologies (VTT) | | D007 | Upgraded atomic/molecular database and CRM for molecules (VTT) | | D008 | Erosion information of 2D surfaces (various morphologies) in comparison to experiments (MPG) | | | | |
| **Management Information**  **Human Resources**:   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | A. Michau | CEA | 2 | D001 (A. Michau, K. Hassouni) | | D. Borodin | FZJ | 1 | D002 (D. Borodin, NN) | | M. Probst | ÖAW | 3 | D003 (M. Probst, S. Huber, J. Romero, D. Süß) | | F. Aumayr | ÖAW | 2 | D004 (F. Aumayr, P.S. Szabo, Ch. Cupak) | | S. Ratynskaia | VR | 7 | D005 (S. Ratynskaia, L. Vignitchouk, L. Brandt, M. Crialesi Esposito, N. Scapin) | | K. Nordlund | VTT | 5 | D006 (K. Nordlund, F. Granberg, N. Ghazemi, A. Lopez Cazalilla) | | M. Groth | VTT | 1 | D007 (M. Groth, A. Holm) | | U. von Toussaint | MPG | 3 | D008 (U. von Toussaint, R. Preuss) | | **Total** |  | 24 |  |   **Hardware/ Machine Resources:**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | n.a. |  |  |  |   **Other resources:**   * HPC requests   **Collaborations:**   * WP TE and WP JET   **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP D / PSI and SOL Modelling |  |  |
| **Task title:** | SP D.3 Impurity Migration Modelling | **Task Ref. Nr.:** | PWIE-SP D.3.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  A. Kirschner (FZJ) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 26-Feb-2021 |
| **Reference Annual Workplan:** *will be added later* | | | |
| Modelling of global and local material migration in fusion experiments involves the benchmarking with existing experiments as well as predictive modelling for future devices. The impurity transport studies can cover intrinsically eroded material and generated dust from wall elements and also externally injected tracer and seeding species. Experiments from various devices such as tokamaks (e.g. AUG, WEST or JET-ILW), the stellarator W7-X and linear devices (MAGNUM-PSI, PSI-2, GyM) are included. Dynamic processes like surface morphology evolution or material mixing should be considered. The benchmarking should lead to a deeper understanding of the involved processes to finally improve predictive modelling of wall life time, fuel retention, and core plasma dilution. Predictive modelling can be performed e.g. for DEMO, W7-X with full tungsten.  Various codes like WallDYN, ERO2.0 can be applied to address the envisaged modelling tasks. | | | |
| **Inputs required:**   * Experimental data (spectroscopy, post-mortem data with respect to erosion/deposition), to be provided by SP B, SP E, WP TE, WP W7X and AUG, WEST, JET-ILW, MAGNUM-PSI, PSI-2, GyM * Plasma background parameters (e.g. from SP D.1, WP TE, or based on experimental data provided by the various devices) | | | |
| **Tasks to be performed:**   * ERO modelling of W transport in WEST in He and D (CEA) * ERO modelling of erosion, migration in GyM (ENEA) * Dynamics of morphology studies and impurity transport (ENEA) * Dynamic morphology studies, comparison with ion beam experiments (FZJ) * ERO modelling for 13CH4 injection in W7-X (FZJ) * Tungsten and beryllium, erosion, migration, deposition modelling (FZJ) * WallDYN modelling for full tungsten W7-X (MPG) * WallDYN modelling with realistic 3D ITER wall (MPG) * ERO modelling for AUG erosion experiments - H mode in He, D (VTT) * Impurity migration modelling (N, W, Be) for JET-ILW and AUG (VTT) | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | **Deliverable ID** | **Deliverable Title** | | D001 | ERO2.0 simulations of tungsten transport in WEST, determination of main tungsten sources in WEST, comparison with spectroscopy (CEA) | | D002 | ERO2.0 simulations of dynamic morphology studies in GyM, ERO2.0 simulations of the transport of sputtered material in GyM, Global ERO2.0 modelling of erosion/deposition in AUG (ENEA) | | D003 | FZJ: D3.1 Model for morphology effects and comparing modelling results with experimental ion beam data, D3.2 Local modelling of 13C MPM injection experiment and comparison to post-mortem data, D3.3 Erosion, impurity migration and deposition modelling for JET-ILW, including recessed areas (FZJ) | | D004 | D4.1 Predictive tungsten migration in W7-X, D4.2 Beryllium/tungsten migration with realistic 3D ITER first wall. (MPG) | | D005 | ERO simulations of AUG and JET-ILW erosion and migration experiments (including nitrogen, tungsten and beryllium) and comparison with experimental data (VTT) | | | | |
| **Management Information**  **Human Resources**:   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | G. Ciraolo | CEA | 2 | D001 (Y. Marandet, N. Fedorcak) | | M. Passoni | ENEA | 5 | D002 (M. Passoni, G. Alberti, A. Ucello) | | A. Kirschner | FZJ | 16 | D003 (D. Reiser, A. Kirschner, H. Xie, NN) | | K. Schmid | MPG | 2 | D004 (K. Schmid) | | A. Hakola | VTT | 4 | D005 (M. Airila, A. Hakola, M. Groth, H. Kumpulainen) | | **Total** |  | 29 |  |   **Hardware/ Machine Resources:**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | n.a. |  |  |  |   **Other resources:**   * HPC requests   **Collaborations:**   * WP TE, WP W7X and WP JET * ITPA DivSOL * International: LHD in Japan, PISCES in US, EAST in China   **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP D / PSI and SOL Modelling |  |  |
| **Task title:** | SP D.4 Neutral Particles Modelling | **Task Ref. Nr.:** | PWIE-SP D.4.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  A. Kirschner (FZJ) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 26-Feb-2021 |
| **Reference Annual Workplan:** *will be added later* | | | |
| Modelling of neutrals implies the analysis of the performance of particle exhaust systems with the aim of optimisation. This is foreseen for current devices and can influence the design of pumping gaps for present machines (e.g. for W7-X) and provides important information for future devices like DEMO. For the modelling codes like DIVGAS can be applied.  The calculation of neutral fluxes, including energy and angular distribution, is important to estimate their impact on the erosion in particular at the first wall. The output will be used within migration modelling studies. The neutral fluxes can be modelled for instance by EIRENE post-processing of SOLPS-ITER simulations. | | | |
| **Inputs required:**   * Plasma parameters (e.g. from ADC, WP TE) | | | |
| **Tasks to be performed:**   * DIVGAS code development and modelling of neutral particle gas dynamics and exhaust for DEMO (KIT) * Post-processing of plasma modelling with SOLPS or OSM/EIRENE to get neutral fluxes to the walls (VTT) | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | **Deliverable ID** | **Deliverable Title** | | D001 | Updated version of DIVGAS and benchmarking simulations studying the newly developed features of the code on the example of DEMO divertor. (KIT) | | D002 | Atomic and molecular fluxes to the wall surfaces (VTT) | | | | |
| **Management Information**  **Human Resources**: *e.g. Person months - Professional Staff, Technical, Staff, Support Staff, Others*   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | Ch. Day | KIT | 9 | D001 (S. Varoutis, C. Tantos) | | M. Groth | VTT | 2 | D002 (M. Groth, A. Järvinen, H. Kumpulainen) | | **Total** |  | 11 |  |   **Hardware/ Machine Resources: e.g. Materials / Linear devices type / days / HHF**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | n.a. |  |  |  | |  |  |  |  |   **Other resources:**   * HPC requests   **Collaborations:**   * WP TE, WP JET * IO and ITPA DivSOL * FTD DES   **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP X / Plasma characterization, laser-  based diagnostic development, and wall  conditioning |  |  |
| **Task title:** | SP X.1 Atomic and molecular processes in attached/detached plasma and sheath | **Task Ref. Nr.:** | PWIE-SP X.1.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  H. J. van der Meiden (DIFFER) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 20-Jan-2021 |
| **Reference Annual Workplan:** | | | |
| This subproject involves in particular the determination of the distribution of the ro-vibrationally excited states of H2 and its isotopologues, in the electronic ground state as well as in electronic excited states in the plasma volume as well as in front of different first wall material surfaces. Moreover, the interplay of atomic and molecular species – including seeding species – during the detachment and recombination process will be investigated and compared with corresponding collision-radiative models from TSVVs.  The plasma-neutral coupling plays a major role in the necessary plasma energy dissipation and momentum loss in the scrape-off layer of the divertor. The second aim is the investigation of the processes occurring in the vicinity of plasma-facing surfaces, where the sheath is the last barrier that determines the power load to the surface in terms of particle flux, sheath heat transmission and e-i and i-n friction (diffusive sheath). The classical sheath model will be validated by experiments and used as input for modelling. Active (e.g. LIF, CARS) and passive spectroscopy (OES and VUV) combined potentially with TS/CTS and Langmuir probes will be deployed to investigate the involved processes and underlying mechanisms with high accuracy and spatial resolution. Linear plasma devices that produce hydrogen and deuterium plasma, are proposed here as first testbed, application in toroidal devices will take place in WP TE and WP 7X. | | | |
| **Inputs required:**   * Linear devices: MAGNUM-PSI, UPP, PSI-2 * VUV LIF diagnostics (dye laser etc. ) and VUV compatible passive spectroscopy systems | | | |
| **Tasks to be performed:**   * Measurement of the atomic density of H(1s) and isotopes: installation TALIF in MAGNUM-PSI. Conceptional design CARS/SARS system for ro-vibrational ground state distribution H2 in MAGNUM (DIFFER) * VUV passive spectroscopy on H/H2 and isotopes in MAGNUM-PSI (FZJ, DIFFER, CU, CIEMAT) * Conceptional design LIF in PSI-2 to measure ro-vibrational ground state distribution (FZJ) * VUV passive spectroscopy on H/H2 in PSI-2 (FZJ, CIEMAT, CU, DIFFER) * Feasibility study multi-photon LIF to measure ro-vibrational ground state distribution of H2 and isotopes (DCU) * Measure ion/electron properties in the proximity of the target surface (Magnum (ion/electron), PUP (electron)) for accurate power load estimations (DIFFER)   Remark: tasks related to LIF concerns mainly diagnostic design and development | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | **Deliverable ID** | **Deliverable Title** | | D001 | TALIF system installed at MAGNUM-PSI and conceptional CARS/SARS system for ro-vib. ground state distribution H2 in MAGNUM-PSI ready (DIFFER) | | D002,D004, D006,D007 | VUV OES results H/H2 (DIFFER, FZJ, CIEMAT, CU) | | D005 | Conceptional design LIF for H/H2 measurements in PSI-2 ready (FZJ) | | D008 | Results feasibility multi-photon LIF for ro-vib. ground state distribution H2(v,J) (DCU) | | D003 | Plasma velocity measurements (CTS) near the surface as function of ne (input SP D), and ne/Te measurements in PUP (DIFFER) | | | | |
| **Management Information**  **Human Resources**: *e.g. Person months - Professional Staff, Technical, Staff, Support Staff, Others*   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | E. Westerhof | DIFFER | 6 | D001, D002, D003 (H. van der Meiden, I. Classen, J. van den Berg-Stolp …) | | B. Unterberg | FZJ | 2 | D004, D005 (M. Reinhart, S. Ertmer, G. Sergienko,..) | | F. Tabares | CIEMAT | 2 | D006 (D. Tafalla,.…) | | P. Veis | CU | 2 | D007 (J. Kristof, …) | | H. Leggate | DCU | 3 | D008 (T. Gans…) | | **Total** |  | 15 |  |   **Hardware/ Machine Resources: e.g. Materials / Linear devices type / days / HHF**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | MAGNUM-PSI | DIFFER | 4 | D001, D002, D003 | | UPP | DIFFER | 4 | D003 | | PSI-2 | FZJ | 5 | D004 | |  |  |  |  |   **Other resources:**  **Collaborations:**   * WP TE, WP 7X * EU-Japan (NAGDIS, LHD)   **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP X / Plasma characterization, laser-  based diagnostic development, and wall  conditioning |  |  |
| **Task title:** | SP X.2 Optimization of laser-based surface analysis diagnostics | **Task Ref. Nr.:** | PWIE-SP X.2.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  H. J. van der Meiden (DIFFER) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 20-Jan-2021 |
| **Reference Annual Workplan:** | | | |
| The scope of this task is the optimization of laser-based techniques for the quantification of fuel content and composition of PFCs (tungsten, beryllium, graphite) and deposits of thoses materials (oxygen, seeding and fuel species). This includes in particular the optimization of ps- and ns Laser-based techniques regarding sensitivity for tungsten-based PFCs in vacuum and at elevated gas pressures mimicking the potential conditions for LIBS and LIA-QMS in ITER, DTT, WEST and elsewhere. Thus, providing vital input on corresponding systems under consideration for ITER and other toroidal devices like e.g. W7-X where also beryllium and graphite needs to be considered in the material mix. Absolute sensitivity, depth resolution, temporal evolution, and identification of the resulting spectra are key parameters of interest that will be validated under different ambient conditions and for different material compositions. Surface roughness is a key element in the interpretation of depth resolution and dedicated ablation modelling for interpretation is required. Overall, the ability to measure the absolute hydrogen isotope content, the He content, and its composition in W- and Be-coatings (C in case of W7-X) with artificial impurities will be assessed.  Exploration of in-situ or in-operando systems in e.g. linear plasma devices are included covering in-addition the recycling, short-term retention and long-term aspect in one hand. The demonstration of in-situ and in-operando techniques under steady-state conditions shall also demonstrate the capability of systems for steady-state toroidal devices as well as provide the ideal test bed for dedicated modelling provided under SP D for such experiments regarding fuel retention/erosion/deposition. Moreover, the diagnostic results will be compared with reference techniques (NRA, LIBS, LIA-QMS, LID-QMS, TDS, SIMS etc.) available in WP PWIE. Unique is here the in-situ Ion Beam analysis in MAGNUM-PSI) . | | | |
| **Inputs required:**   * Machines: MAGNUM-PSI +IBA+LIBS, PSI-2 +LIBS+LIA-QMS * Accelerators * Samples: tiles and coatings from SP B | | | |
| **Tasks to be performed:**  LIBS performance enhancement:   * Comparison ps vs. ns LIBS regarding absolute composition and D content in reference and ITER-relevant coatings which can include impurities (FZJ, CU, UT, ISSPUL, CEA) * Comparison Single Puls vs. Double Puls LIBS (or alternative LIBS signal enhancement methods) regarding absolute material composition and D content in ITER- and DEMO-relevant W including self-damage W and reference coatings. (FZJ, ENEA, CEA) * (CF-) LIBS (ps, ns SP or DP) on samples (if available) from different devices (tokamaks or W-7X) (collab. SP B) (ISSP UL, CU, UT, VTT, FZJ, ENEA) * Improve CF LIBS analysis by application of machine learning algorithm (IPPLM) * (CF-)LIBS on Be containing coatings with different type of fuel content (VTT, UT, CU) * CF-LIBS on produced reference samples before and after *He* loading (FZJ, CU, UT, ENEA)   Physics related to PWI:   * Investigate erosion/deposition/fuel retention (including He) by *in situ* (CF)-LIBS and NRA/RBS in MAGNUM, LIBS and LIA-QMS/EDX in PSI-2 with subjects of interest: outgassing, recycling, and role of impurities (O, N), Tsurface, and implantation energy on retention (DIFFER, FZJ, UT) | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | **Deliverable ID** | **Deliverable Title** | | D001,D005, D011,D015, D020 | Comparison of ps vs. ns LIBS: absolute content and composition | | D002,D006 | Comparison SP vs. DP LIBS, or alternative LIBS signal enhancement methods: absolute fuel content in W samples and composition | | D003,D007, D012,D016, D021 | (CF)-LIBS (ps/ns or SP/DP) on samples from different toroidal devices: absolute content and composition (in depth) | | D010 | Report on CF-LIBS analysis by application of machine learning algorithm | | D013,D017 | Analysis of Be containing coatings with (CF)-LIBS: absolute content and composition | | D004,D008, D018 | (CF)-LIBS results *He* loaded samples and surface modifications | | D009,D014, D019,D022 | Reference measurements of outgassing, recycling, and retention after D plasma loading: absolute content and composition in W and reference samples | | | | |
| **Management Information**  **Human Resources**: *e.g. Person months - Professional Staff, Technical, Staff, Support Staff, Others*   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | E. Bernard | CEA | 2 | D001 (A. Bultel...) | | E. Westerhof | DIFFER | 2 | D022 (H. van der Meiden, J. Vernimmen,…) | | S. Almaviva | ENEA | 4 | D002, D003, D004 (S. Almaviva,, ...) | | E. Wüst | FZJ | 9 | D005, D006, D007, D008, D009 (G. Sergienko, M. Hubeny, N. Klose...) | | M. Chernyshova | IPP\_LM | 2 | D010 (P. Gasior, M. Kubkowska,...) | | P. Veis | CU | 8 | D011, D012, D013, D014 (A. Marin Roldan. J. Kristof,…) | | M. Kiisk | UT | 9 | D015, D016, D017, D018, D019 (I. Jögi, P. Paris, ...) | | J. Butikova | ISSP UL | 3 | D020, D021 | | **Total** |  | 39 |  |   **Hardware/ Machine Resources: e.g. Materials / Linear devices type / days / HHF**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | MAGNUM-PSI | DIFFER | 4 | D022 | | PSI-2 | FZJ | 15 | D005, D006, D007, D008, D009 | | Accelerator | DIFFER | 4 | D022 | |  |  |  |  |   **Other resources:**  **Collaborations:**   * WP TE, WP W7X and WP JET   **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP X / Plasma characterization, laser-  based diagnostic development, and wall  conditioning |  |  |
| **Task title:** | SP X.3 Characterisation and optimisation of TOMAS wall conditioning plasmas | **Task Ref. Nr.:** | PWIE-SP X.3.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  H. J. van der Meiden (DIFFER) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 20-Jan-2021 |
| **Reference Annual Workplan:** | | | |
| Ion Cyclotron Wall Conditioning (ICWC) is included in the ITER Research Plan as well as part of the wall conditioning of long-pulse facilties. A high and isotropic flux of neutral particles is generated in these low-density discharges through elementary collision processes. The effectiveness of ICWC for modifying the plasma facing surfaces, evidenced in numerous experiments on tokamak, results largely from these neutrals. This subproject proposes to study the further the production and role of energetic neutrals in ICWC and its impact on wall conditioning, thus, the impurity removal and the fuel content removalTomator1D predicts a neutral hydrogen particle flux on TOMAS that is sufficiently high to be detected by a time-of-flight neutral particle analyser provided in FP8. The energy distribution of neutrals can be resolved by the ToF NPA in the energy range of 10 to 1000 eV. Optimisation of the plasma in connection to modelling predictions shall enhance the efficiency of the neutrals for wall conditioning purpose.  The stainless-steel TOMAS device (120mT Continuous-wave operation) is equipped with a wide frequency band ICWC plasma source, an upgraded Electron Cyclotron Resonance Heating (ECRH) system and a W7-X prototype DC glow discharge anode. In the present framework a material sample system as well as multiple plasma diagnostic tools will be installed (LP, OES, RFA etc.). They permit a better characterisation and optimisation (pressure, composition, pumping speed, cycling, heating power) which will feed into predictions for tokamaks and stellarators.  Moreover, dedicated cleaning attempts on reference samples with pre-characterised surface conditions and stellarator/tokamak samples will be applied. This work is accompanied with dedicated pre- and post-characterisation of material samples. | | | |
| **Inputs required:**   * Characterizing the particle fluxes to PFCs in ICWC and ECWC conditioning discharges * TOMAS facility operational with upgraded diagnostics (flux, energy, temperature, plasma) * Reference samples and samples after plasma exposure in toroidally confined plasmas (WP TE or W7X) * Access to surface analysis stations in FZJ, VR, and ERM-KMS (together with SP B) | | | |
| **Tasks to be performed:**   * Diagnostic upgrade and ECWC, ICWC, RF plasma characterisation in TOMAS * Modelling of TOMAS plasma to describe neutral particle conditions as well optimise efficiency and homogeneity of the plasma * Plasma-facing material cleaning in TOMAS with optimisation of experimental conditions * Pre- and post characterisation of reference samples applied to cleaning attempts * Coordination of TOMAS experiments and relation to ITER conditions as well as other toroidal facilities like W7-X, WEST, AUG | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | Deliverable ID: | Deliverable Title: | | D001,D005, D008,D010 | ECWC, ICWC, and GDC plasma characterization in TOMAS (LPP-ERM/KMS, FZJ, VR, KIPT) | | D002,D006 | Report on fuel/impurity removal studies at reference samples in TOMAS (LPP-ERM/KMS, FZJ) | | D003 | Report on a comparison of TOMAS studies with ICWC, ECWC and GDC and comparison with stellarator and tokamak experiments (LPP-ERM/KMS) | | D007,D009 | Pre- and post-characterization of samples used for cleaning in TOMAS (VR, FZJ) | | D004,D011 | Modeling of wall conditioning RF-based plasmas (LPP-ERM/KMS, KIPT) | | | | |
| **Management Information**  **Human Resources**: *e.g. Person months - Professional Staff, Technical, Staff, Support Staff, Others*   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | T. Wauters | LPP-ERM/KMS | 7 | D001, D002, D003, D004 | | S. Möller | FZJ | 4 | D005, D006, D007 (S. Möller, M. Rasinski, D. Nikolai, ...) | | P. Petersson | VR | 3 | D008, D009 (L. Dittrich, P. Petterson,…) | | V. Moiseenko | KIPT | 4 | D010, D012 (V. Moiseenko, Y. Kovtun, ...) | | **Total** |  | 18 |  |   **Hardware/ Machine Resources: e.g. Materials / Linear devices type / days / HHF**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | TOMAS | FZJ | 15 | D005, D006 | | Accelerator | VR | 5 | D009 | | Accelerator | FZJ | 3 | D007 | |  |  |  |  |   **Other resources:**   * Travel for TOMAS campaigns   **Collaborations:**   * WP TE, WP W7X * IO and ITPA DivSOL   **Other information:** | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP-ADC /  *Advanced Divertor Solutions for Power Exhaust in DEMO* |  |  |
| **Task title:** | SP-ADC.F / *Modelling of advanced divertor configurations for DEMO and PEX solutions* | **Task Ref. Nr.:** | PWIE-SP ADC.F.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  G. Calabrò (ENEA) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 20-Jan-2021 |
| **Reference Annual Workplan:** | | | |
| The SP-ADC are addressing the physics work regarding the advanced divertor solutions for DEMO and the compatibility with engineering constraints. The physics part is covering predictive modelling of the most favorable solutions post an assessment end of 2020 by WP ADC-DTT. Subproject SP-ADC.G will be devoted, to improve the 2020 predictions of detached regimes in ADCs including:   * (i) the effects of kinetic neutrals and * (ii) sensitivity studies for the most uncertain input parameters regarding e.g. plasma transport.   Plasma conditions and physical mechanisms determining the onset of detachment and operational window will be analyzed for each configuration by SOLPS-ITER code and EMC3-EIRENE The observed dependencies will be used as a basis for building simplified models and to suggest validation methods for the PEX experiment. Plasma conditions and physical mechanisms determining the onset of detachment and operational window will be analyzed for each configuration. The observed dependencies will be used as a basis for building simplified models and to suggest validation methods for the PEX experiments. Strong link with WP DES, WP TE and TSVVs is foreseen, PWIE – SP D (neutral modelling activities for pumping design). | | | |
| **Inputs required:**   * ADC Equilibria for SOLPS-ITER mesh generation (delivered by WP ADC-DTT’s final report) * Engineering constraints to be considered on SOLPS-ITER mesh generation (delivered by WP ADC-DTT’s final report and reviewed by SP-ADC.I) | | | |
| **Tasks to be performed:**   * Understanding the effects of connection length and flux flaring on power exhaust in the XD and SX configurations, identification of most potential solution, without kinetic neutral simulations * Consideration of potential effects of kinetic neutrals in ADCs based on the relevant SN solutions * Physical understanding of potential benefits of SF- and the sensitivity of this configuration to the level of separatrix separation * Investigating the effects of drifts and core radiators in the CDN configuration, without kinetic neutral simulations * Initial set-up of DDN simulations (provisional, depending on the outcome of the CDN simulations) | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | Deliverable ID: | Deliverable Title: | | D001 | Analysis and SOLPS-ITER modelling of DEMO XD considering the roles of connection length, flux flaring and neutral model (ENEA) | | D002 | Analysis and SOLPS-ITER modelling of DEMO SX considering the role of the neutral model and the dimensions of the outer divertor leg (ENEA) | | D003,D004 | Analysis and SOLPS-ITER modelling of DEMO SF- including several configurations to understand the sensitivity of the solutions to the levels of separatrix and X-point separation (EFPL) | | D005 | Development of simplified models based on simulation results for XD and SX to suggest validation methods for the PEX experiments (VTT) | | D006 | Sensitivity studies (transport coefficients, input power) for XD and SX configurations using SOLPS-ITER (IPP\_LM) | | D007 | Support on mesh creation and enhancing credibility of fluid neutrals results for all configurations applying hybrid numerical models (LPP-ERM/KMS) | | D008 | DEMO CDN modelling including drifts/core radiators with SOLPS-ITER (VTT) | | | | |
| **Management Information**  **Human Resources**: *e.g. Person months - Professional Staff, Technical, Staff, Support Staff, Others*   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | F. Subba | ENEA | 2.5 | D001 (F. Subba, L. Aho-Mantila and SP F team) | | G. Rubino | ENEA | 2.5 | D002 (G. Rubino, L. Aho-Mantila and SP F team) | | O. Pau | MPG | 4 | D003 (O. Pau, L. Aho-Mantila and SP F team) | | C. Colandrea | EPFL | 3 | D004 (C. Coandrea, L. Aho-Mantila and SP F team) | | A. Järvinen | VTT | 3 | D005 (A. Järvinen, L. Aho-Mantila and SP F team) | | P. Chmielewski | IPP\_LM | 2 | D006 (P. Chimielewski, L. Aho-Mantila and SP F team) | | M. Blommaert | LPP-ERM/KMS | 6 | D007 (M. Blommaert, S. Van den Kerkhof, M. Baelmans, ...) | | L. Aho-Mantila | VTT | 1 | D008 | | **Total** |  | 24 |  |   **Hardware/ Machine Resources: e.g. Materials / Linear devices type / days / HHF**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | n.a. |  |  |  | |  |  |  |  |   **Other resources:**   * HPC request   **Collaborations:**   * WP TE, WP DES * EU-CHINA   **Other information:**  Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP-ADC /  *Advanced Divertor Solutions for Power Exhaust in DEMO* |  |  |
| **Task title:** | SP-ADC.G / *Experimental assessment of PEX solutions and modelling interpretation* | **Task Ref. Nr.:** | PWIE-SP ADC.G.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  G. Calabrò (ENEA) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 20-Jan-2021 |
| **Reference Annual Workplan:** | | | |
| The SP-ADC are addressing the physics work regarding the advanced divertor solutions for DEMO and the compatibility with engineering constraints. The physics part is covering predictive modelling of the most favorable solutions post an assessment end of 2020 by WP ADC-DTT. Moreover, experimental assessment of these solutions in present-day devices as well as in future PEX facilities in collaboration with WP TE is explored. Subproject SP-ADC.G will develop reduced models from existing MST1 (or WP TE) simulations or experimental data to try to obtain scaling laws applicable also for DEMO size and compare these with scaling laws extracted from all existing DEMO scale simulations. Experimental results and experimentally validated detachment models will be compared to the results from SP-ADC.F**.** This will support the validation of DEMO simulations and increase understanding of how the PEX solutions scale to the reactor size. Strong link with WP DES, WP TE and TSVVs is foreseen. | | | |
| **Inputs required:**   * ADC edge interpretative simulations (MST1 and/or WP TE) * ADC experimental data (MST1 and/or WP TE) * MST1/WP TE include = TCV, MAST-U, WEST and AUG | | | |
| **Tasks to be performed:**   * Initial reduced model from existing MST1 (or WP TE) simulations or experimental data in view of scaling laws applicable to DEMO size machine * Comparison of experimental results and experimentally validated detachment models with SP-ADC.F simulations | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | Deliverable ID: | Deliverable Title: | | D001,D002 | Initial reduced model from experimental ADC (MST1 or WP TE) 3D edge simulations and experimental data to scaling laws applicable to DEMO size machine (EFPL, CEA, MPG) | | D003 | Comparison of experimental results and experimentally validated detachment models with SP-ADC.F simulations (EFPL, CEA, MPG) | | | | |
| **Management Information**  **Human Resources**: *e.g. Person months - Professional Staff, Technical, Staff, Support Staff, Others*   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | T. Lunt | MPG | 6 | D001 (N. Fedorczak, H. Reimerdes) | | N. Fedorczak | CEA | 2 | D002 (T. Lunt, H. Reimerdes) | | H. Reimerdes | EPFL | 2 | D003 (T. Lunt, N. Fedorczak) | | **Total** |  | 10 |  |   **Hardware/ Machine Resources: e.g. Materials / Linear devices type / days / HHF**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | |  |  |  |  | |  |  |  |  |   **Other resources:**   * HPC request   **Collaborations:**   * WP TE, WP DES * EU-CHINA   **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP-ADC /  *Advanced Divertor Solutions for Power Exhaust in DEMO* |  |  |
| **Task title:** | SP-ADC.H / Engineering boundary conditions related to DTT as ADC test-bed | **Task Ref. Nr.:** | PWIE-SP ADC.H.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  G. Calabrò (ENEA) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 20-Jan-2021 |
| **Reference Annual Workplan:** | | | |
| The SP-ADC are addressing the physics work regarding the advanced divertor solutions for DEMO and the compatibility with engineering constraints. The engineering part focus on the compatibility with DEMO constraints in view of configurations, stability, and thermomechanical and electromagnetic loads; the work is coordinated with the FTD. Compatibility of potential DEMO ADC solutions with DTT will be also investigated. Subproject SP-ADC.H will explore engineering DTT compatibility exploitation for ADC configurations. Assessment of controllability of ADC configuration, in connection with WPs DES and DIV, taking into account engineering constrains will be investigated. | | | |
| **Inputs required:**   * DEMO ADC equilibria configurations (delivered by WP ADC-DTT’s final report) * Recommendations for engineering aspects of DEMO VS control (delivered by WP ADC-DTT’s final report and WP PMI 2020 reports, in particular KDII#3 final report) | | | |
| **Tasks to be performed:**   * Engineering boundary conditions related to DTT as ADC test-bed (i.e. best promising configurations described in WP ADC-DTT’s final report) | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | Deliverable ID: | Deliverable Title: | | D001,D002 | Engineering compatibility of best promising configurations described in WP ADC-DTT’s final report for DTT facility: recommendations for control and equilibria design (ENEA) | | D003 | Engineering compatibility of best promising configurations described in WP ADC-DTT’s final report for DTT facility: recommendations for VDE and disruption consequences (ENEA) | | | | |
| **Management Information**  **Human Resources**: *e.g. Person months - Professional Staff, Technical, Staff, Support Staff, Others*   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | R. Ambrosino | ENEA | 7 | D001 (G. Ramogida, R. Lombroni, F. Giorgetti, P. Fanelli) | | G. Ramogida | ENEA | 1 | D002 (R. Ambrosino, R. Lombroni, F. Giorgetti, P. Fanelli) | | R. Lombroni | ENEA | 7 | D003 (R. Ambrosino, G. Ramogida, F. Giorgetti, P. Fanelli) | | **Total** |  | 15 |  |   **Hardware/ Machine Resources: e.g. Materials / Linear devices type / days / HHF**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | n.a. |  |  |  | |  |  |  |  |   **Other resources:**  **Collaborations:**   * WP TE, WP DES * EU-CHINA   **Other information:**  Connected to TSVVs associated with WP PWIE | | | |

|  |  |  |  |
| --- | --- | --- | --- |
| **Work Package:** | WP PWIE | **Link to IMS:** | [*will*](https://ims.euro-fusion.org/TaskSpecification/ReportViewer?id=4870&reportName=TaskSpecification&createAttachmentData=true) *be added later* |
| **Subproject:** | SP-ADC /  *Advanced Divertor Solutions for Power Exhaust in DEMO* |  |  |
| **Task title:** | SP-ADC.I / *Engineering boundary conditions related to DEMO ADC solutions* | **Task Ref. Nr.:** | PWIE-SP ADC.I.T-T001 |
| **WP Leader**  **SP Coordinator** | S. Brezinsek (FZJ)  G. Calabrò (ENEA) | **Issue:** | 1 |
| **PSO:** | M. Reinhart / A. de Schepper (FZJ) |  |  |
| **Start Event:** | Start of the WP PWIE | **Planned Start Date:** | 01-Jan-2021 |
| **End Event:** | Final Report accepted | **Planned End Date:** | 31-Dec-2022 |
| **Task Reviewer:** | David Douai (CO) | **Date:** | 20-Jan-2021 |
| **Reference Annual Workplan:** | | | |
| The SP-ADC are addressing the physics work regarding the advanced divertor solutions for DEMO and the compatibility with engineering constraints. The engineering part focus on the compatibility with DEMO constraints in view of configurations, stability, and thermomechanical and electromagnetic loads; the work is coordinated with the FTD. Compatibility of potential DEMO ADC solutions with DTT will be also analysed. Subproject SP-ADC.I will exploit engineering DEMO compatibility for most favourable ADC solutions configurations in terms of plasma-wall contact points during disruptions and initial definition of the required size and configuration of the divertor including baffle. | | | |
| **Inputs required:**   * DEMO ADC equilibria configurations and geometry layout delivered by WP ADC-DTT’s final report * New ADC equilibria that will produced under WPDES activity (which have a realistic TF coil configuration, hence PF coil) * Recommendations for engineering aspects of DEMO VS control (delivered by WP ADC-DTT’s final report and WPPMI 2020 activity) | | | |
| **Tasks to be performed:**   * Plasma-Wall contact points during disruptions and initial evaluation of ADC transients for the heat flux impact point of view * Initial definition of required size and configuration of ADCs divertor including the baffle. | | | |
| **Deliverables:** *(the Deliverables will receive IMS Deliverable IDs later)*   |  |  | | --- | --- | | Deliverable ID: | Deliverable Title: | | D001,D002, D004 | Plasma-Wall contact points during disruptions and initial evaluation of ADC transients for the heat flux impact point of view (ENEA, LPP-ERM/KMS) | | D003 | Initial definition of required size and configuration of ADCs divertor including the baffle (ENEA) | | | | |
| **Management Information**  **Human Resources**: *e.g. Person months - Professional Staff, Technical, Staff, Support Staff, Others*   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | P. Fanelli | ENEA | 5 | D001 (C. Stefanini, F. Giorgetti, R. Lombroni, F. Vivio and V. Berardi) | | C. Stefanini | ENEA | 3 | D002 (P. Fanelli, F. Giorgetti, R. Lombroni, F. Vivio and V. Berardi) | | F. Vivio | ENEA | 2 | D004 (P. Fanelli, C. Stefanini, F. Giorgetti, P. Fanelli) | | W. Dekeyser | LPP-ERM/KMS | 2 | D004 | | **Total** |  | 12 |  |   **Hardware/ Machine Resources: e.g. Materials / Linear devices type / days / HHF**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | n.a. |  |  |  | |  |  |  |  |   **Other resources:**  **Collaborations:**   * WP TE, WP DES * EU-CHINA   **Other information:**   * Connected to TSVVs associated with WP PWIE | | | |

## ANNEX 2: WPPWIE 2021 facility resources summary

**Table 20: 2021 WPPWIE facilities @ 70% resources per activity**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Facility | ***PSI-2*** | **MAGNUM-PSI** | **JULE-PSI** | **UPP** |
| RU | ***FZJ*** | **DIFFER** | **FZJ** | **DIFFER** |
| Activity | days | days | days | days |
| SPA.1 | 14 | 4 |  |  |
| SPA.2 |  | 7 |  |  |
| SPA.3 | 11 | 4 |  |  |
| SPA.4 | 5 |  |  |  |
| SPB.1 | 15 | 4 |  |  |
| SPB.2 |  |  |  |  |
| SPB.3 |  |  |  |  |
| SPB.4 |  |  |  |  |
| SPC.1 |  | 4 |  | 8 |
| SPC.2 |  |  |  |  |
| SPC.3 |  |  |  |  |
| SPC.4 | 5 |  |  |  |
| SPX.1 | 5 | 2 (4) |  | 4 |
| SPX.2 | 15 | 2 (4) |  |  |
| SPX.3 |  |  |  |  |
| **TOTAL** | **70** | **27** | **0** | **12** |

For MAGNUM-PSI, 31 days are scheduled for operation in WPPWIE activities. Funding is only available for 27 days, therefore the days for SPX.1 and SPX.2 are reduced by 4 days in this table.

**Table 21: 2021 WPPWIE facilities @ 40% (heat load + Plasma) resources per activity**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Facility | ***JUDITH-2*** | ***GLADIS*** | ***QSPA*** | ***OLMAT*** | ***GYM*** | ***TOMAS*** |
| RU | ***FZJ*** | ***MPG*** | ***KIPT*** | ***CIEMAT*** | ***ENEA*** | ***FZJ*** |
| Activity | days | days | days | days | days | days |
| SPA.1 | 10 | 4 | 10 | 4 |  |  |
| SPA.2 |  |  |  |  |  |  |
| SPA.3 | 10 | 4 | 5 |  |  |  |
| SPA.4 |  |  | 5 |  |  |  |
| SPB.1 |  |  |  |  | 15 |  |
| SPB.2 |  |  |  |  |  |  |
| SPB.3 |  |  |  |  |  |  |
| SPB.4 |  |  |  |  |  |  |
| SPC.1 |  |  |  |  |  |  |
| SPC.2 |  |  |  |  |  |  |
| SPC.3 |  |  |  |  |  |  |
| SPC.4 |  |  |  |  |  |  |
| SPX.1 |  |  |  |  |  |  |
| SPX.2 |  |  |  |  |  |  |
| SPX.3 |  |  |  |  |  | 15 |
| **TOTAL** | **20** | **8** | **20** | **4** | **15** | **15** |

**Table 22: 2021 WPPWIE facilities @ 40% (accelerators) resources per activity**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Facility name | ***Acc*** | ***Acc*** | ***Acc*** | ***Acc*** | ***Acc*** | ***Acc*** | ***Acc*** | ***Acc*** | ***Acc*** |
| RU | ***MPG*** | ***DIFFER*** | ***FZJ*** | ***VR*** | ***JSI*** | ***RBI*** | ***VTT*** | ***IST*** | ***NCSRD*** |
| days | days | days | days | days | days | days | days | days | days |
| SPA.1 |  |  |  |  |  |  |  |  |  |
| SPA.2 |  |  |  |  |  |  |  |  |  |
| SPA.3 | 10 |  |  |  |  |  |  |  |  |
| SPA.4 |  |  |  |  |  |  |  |  |  |
| SPB.1 |  | 3 | 3 | 5 |  |  |  |  |  |
| SPB.2 | 8 |  | 3 | 5 | 5 | 5 | 2 |  |  |
| SPB.3 | 7 |  | 1 |  |  |  | 2 | 5 | 5 |
| SPB.4 |  |  |  |  |  | 5 | 1 | 5 |  |
| SPC.1 | 2 | 8 |  |  | 7 |  |  |  |  |
| SPC.2 |  |  |  |  |  |  |  |  |  |
| SPC.3 | 25 |  |  |  | 8 |  |  |  |  |
| SPC.4 |  |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |  |  |  |
| SPX.1 |  |  |  |  |  |  |  |  |  |
| SPX.2 |  | 4 |  |  |  |  |  |  |  |
| SPX.3 |  |  | 3 | 5 |  |  |  |  |  |
| **TOTAL** | **52** | **15** | **10** | **15** | **20** | **10** | **5** | **10** | **5** |

1. Days if needed – need to be balanced with other SPs [↑](#footnote-ref-1)
2. Days if needed – need to be balanced with other SPs [↑](#footnote-ref-2)