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| **WPPWIE Deliverables Status Report** | | | | | **Date:** | | | 01-Sep-2022 | | |
| **Subproject:** | SP X / Plasma characterization, laser-  based diagnostic development, and wall conditioning | | | | **Deliverable ID** | | | PWIE-SP X.2.T-T002-D001 | | |
| **Deliverable owner:** | E. Bernard (CEA) | | | | **Deliverable due date** | | | 31-12-2022 | | |
| **WP Leader:**  **SP Coordinator:** | S. Brezinsek (FZJ)  H. J. van der Meiden (DIFFER) | | | |  | | |  | | |
| **Task title:** | SP X.2 Optimization of laser-based surface analysis diagnostics | | | | | | | | | |
| **Deliverable title:** | Comparison ps vs. ns LIBS (CEA) | | | | | | | | | |
| **Status:** |  | **Completed** |  | **Partially completed** | |  | **Delayed** | |  | **Cancelled** |
| Please write a short status report (max. ½ pages) here.  Please check the status of the deliverable(s) with a “x” in the row above.  If the deliverable(s) are delayed, please also indicate an estimated completion date in the report text.  If the deliverable(s) include machine time, please indicate the number of days that have been used for the deliverable(s) in the report text.  For reference, the specification of this task from the PMP is given below. | | | | | | | | | | |
| **Reference from PMP:** | | | | | | | | | | |
| 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 those 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 WPPWIE. Unique is here the in-situ Ion Beam analysis in MAGNUM-PSI. LAMIS is a new technique based on LIBS permitting isotopes of wall materials and will be explored in FZJ. | | | | | | | | | | |
| **Inputs required:**   * Machines: MAGNUM-PSI, PSI-2 * 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 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, LAMIS, 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), LAMIS qualification for W7-X application (FZJ) | | | | | | | | | | |
| **Deliverables:**   |  |  | | --- | --- | | **Deliverable ID** | **Deliverable Title** | | D001 | Comparison ps vs. ns LIBS (CEA) | | D002 | LIBS and reference measurements after outgassing (DIFFER) | | D003 | Comparison SP vs. DP LIBS / (CF)-LIBS on samples from different toroidal devices / (CF)-LIBS results *He* loaded samples and surface modifications (ENEA) | | D004 | Comparison ps vs. ns LIBS, SP vs. DP LIBS / (CF)-LIBS on samples from different toroidal devices / (CF)-LIBS results *He* loaded samples and surface modifications / Reference measurements after outgassing (FZJ) | | D005 | Report on LIBS analysis by application of machine learning algorithm (IPPLM) | | D006 | Comparison ps vs. ns LIBS / (CF)-LIBS on samples from different toroidal devices / Analysis of Be containing coatings with (CF)-LIBS / Reference measurements after outgassing (CU) | | D007 | Comparison ps vs. ns LIBS / (CF)-LIBS on samples from different toroidal devices / Analysis of Be containing coatings with (CF)-LIBS / (CF)-LIBS results *He* loaded samples and surface modifications / Reference measurements after outgassing (UT) | | D008 | Comparison ps vs. ns LIBS / (CF)-LIBS on samples from different toroidal devices (ISSP-UL) | | D009 | Reference measurements of outgassing, recycling, and retention after D plasma loading: absolute content and composition in W and reference samples (DIFFER) (Transfer 2021) | | D010 | Comparison of ps vs. ns LIBS: absolute content and composition / (CF)-LIBS (ps/ns or SP/DP) on samples from different toroidal devices: absolute content and composition (in depth) (ISSP-UL) (Transfer 2021) | | | | | | | | | | | |
| **Management Information**  **Human Resources (2022)**:   |  |  |  |  | | --- | --- | --- | --- | | **Deliverable Owner** | **Beneficiary** | **PM** | **Deliverable (Team)** | | E. Bernard | CEA | 2 | D001 (A. Bultel...) | | H. van der Meiden | DIFFER | 2+2 | D002, D009 (H. van der Meiden, J. Vernimmen,…) | | S. Almaviva | ENEA | 4 | D003 (S. Almaviva,, ...) | | G. Sergienko | FZJ | 9 | D004 (G. Sergienko, M. Hubeny, E. Wüst...) | | P. Gasior | IPPLM | 2 | D005 (P. Gasior, M. Kubkowska,...) | | P. Veis | CU | 8 | D006 (A. Marin Roldan. J. Kristof,…) | | M. Kiisk | UT | 9 | D007 (I. Jögi, P. Paris, ...) | | J. Butikova | ISSP UL | 3+3 | D008, D010 | | **Total** |  | 44 |  |   **Hardware/ Machine Resources: e.g. Materials / Linear devices type / days / HHF**   |  |  |  |  | | --- | --- | --- | --- | | **Device** | **Beneficiary** | **Days** | **Related Deliverable** | | MAGNUM-PSI | DIFFER | 5+2 | D002, D009 | | PSI-2 | FZJ | 15 | D003 | | Accelerator | DIFFER | 4+4 | D002, D009 | |  |  |  |  |   **Other resources:**  **Collaborations:**   * WPTE and WPW7X * ITER and ITPA DIAG * EU-RU and EU-US on LID-QMS and LIBS   **Other information:**  Connected to TSVVs associated with WP PWIE | | | | | | | | | | |