TSVV15 overview

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The main principles

- The present state of the community is that Pulse Design Tools have been developed by some experiments and used mostly for that experiment.
- The proposed new TSVV project is to evolve from this situation to a more coordinated and harmonised landscape, by porting the existing tools to different experiments (task 1), develop interoperable components and framework that can benefit to all PDT prototypes (task 2 and 3), with a specific effort until the end of 2025 on transport+free boundary applications (task 4).
- Maximise the mutualisation of modules (e.g. transport, fuelling, H&CD, equilibrium), coupling techniques and infrastructure solutions
- Apply the tools to multiple experiments and benchmark them
- Define a possible convergence strategy for the next period (2026-2027)

IMAS interfaces

Task 1 overview : Demonstration of PDT prototype (porting at existing machines)

- Application of PDT prototypes to new machines
  - inform which parts of the physics need refinement and/or machine-specific tuning
  - test of interoperability
- IMAS (for input and output of the PDT at least)
  - ease comparison of different PDT prototypes on different machines
  - ease possible further integration
- *Deliverables:*
  - D1.1 interim report on task 1 activities - December 2024
  - D1.2 PDT prototype (Fenix, ASTRA-MEQ-controller) validated for existing TCV data and ready for use for new discharges – July 2025
  - D1.3 PDT prototype (METIS/RAPTOR-MEQ) validated for existing COMPASS data, and ready for use on COMPASS Upgrade - December 2025
  - D1.4 PDT prototype (METIS-MEQ/NICE) validated for existing RFX-MOD data, and ready for use on RFX-MOD2 - December 2025

Task 2 overview : Development of Reduced Models and Workflow (not covered by other TSVVs)

- The TSVV-15 task 2 will support the development and/or validation of new surrogate models that fill-in the gaps identified within current PDT frameworks, namely:
  - Heating and current drive systems: Validation of model of EC and NBI deposition, interaction of NTM-EC wave (2 models will be developed and tested)
  - Plasma fuelling and SOL-divertor description: Surrogate model for pellet injection (1 model), SOL neutrals description, model for plasma density and integration into density feedback, improvement of divertor model and real-time exhaust model (3 models)
  - MHD and transport for accurate power balance: Prediction of NTM onset, surrogate model for prediction of no-wall beta limit and of error field induced locked-mode threshold (1 model)
- Milestone: For each new module, finalisation of complete physics models / databases / datasets (learning+testing) for at least one machine - March 2025.
- Deliverables:
  - D2.1: interim report on the task 2 activities – December 2024
  - D2.2: successful simulation of the given functionality (within given machine / experimental parameters) in a single PDT prototype for all models - October 2025
  - D2.3: evaluation of the relevance of the various reduced models, aiming at merging their functionalities to have a single model for each physics topic - December 2025

Task 3 overview : Design the PDT framework for integration of modules provided by other TSVVs

- Task added by the Scientific Board in the second Call
- Reinforce synergies i) between works proposed by the different teams in TSVV-15, ii) between TSVVs and iii) with external activities
  - IMAS interfaces for interoperability, test new modules from task 2 and other TSVVs in at least two different frameworks. Benchmarking activities between the present tools will also be organised to compare their performances
  - Develop synergies with other TSVVs (in particular TSVV11)
  - Develop synergies with ITER Org. which is developing a Pulse Design Simulator using MUSCLE3
- Will be addressed essentially by the Coordination team, using input from the other tasks
- *Deliverables:*
  - D3.1 interim report on task 3 activities – December 2024
  - D3.2 benchmark of PDT prototypes from task 4 on simulations of cases from 2 different experiments, with potential interface to models from other TSVVs – October 2025
  - D3.3 evaluation report of the various tools based on this benchmark (strength / weaknesses of the overall tool and of the main physics models available in each tool) - December 2025

Task 4 overview : Magnetic Equilibrium and Control for PDT

- Group of codes for free boundary evolution, including (some) transients
- Different initial targets for each group (connection to kinetic code, add breakdown phase, speed up,…)
- Using existing code and ongoing development, but with the emphasis on interoperability (see also task 3)
- Codes will be applied to at least one more device than the one it was originally made for

- *Deliverables:*
  - D4.1a Coupling between breakdown and early ramp-up for DYON-FIESTA & CREATE-BD – Dec. 2024
  - D4.1b Coupling between magnetic codes and kinetic codes for NICE-METIS & RAPTOR-FBT – Dec. 2024
  - D4.2 Test run with inputs and outputs for each code on their ‘home’ device – July 2025
  - D4.3 Application of each code to a ‘foreign’ machine using D4.2 for comparison and cross-validation – Dec. 2024