

WP-CD

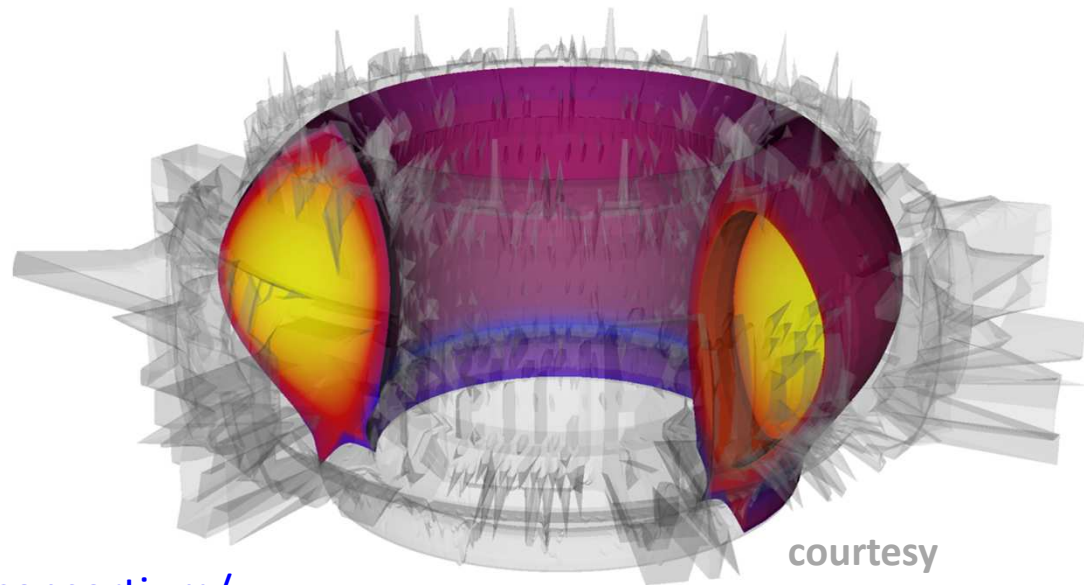
Code Development for Integrated Modelling

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courtesy
Hajo Klingshirn

Code Development for integrated modelling

! NEW PROJECT : DELIVERABLE ORIENTED APPROACH

"Achieving the Mission goals requires significant development of existing modelling codes with a particular focus on integrated modelling."

WP-CD SCOPE

- **"provide a suite of codes that can be validated on existing machines and used for ITER and DEMO predictions"**
- **"build on the large body of existing modelling codes developed by the EFDA Associates including the infrastructure, toolset and codes developed under the EFDA ITM Taskforce"**
[...] including addition of new physics to existing models, coupling of codes into integrated workflows and code optimisation
- **"Specific ITER simulation work in support of ITER IO and F4E with specific deliverables tbd in close collaboration with them"**

WP-CD Deliverables

ROADMAP 2020 HEADLINES

- **Extended linear stability chain** (equilibrium coupled to MHD stability, edge instabilities, fast particle driven instabilities) **H1.4**
- **Core transport simulator** including various equilibrium and transport modules, turbulence modules, impurities, pellets, neutrals, sawteeth, NTM, Heating and Current Drive modules (extended to synergies, EC, NBI, IC, LH, fast-ions) with improved physics **H1.1; H1.5; H1.6; H1.8, H1.9**
- **Coupled feedback controlled free boundary plasma simulator and transport solver** **H1.8**
- **Inclusion of synthetic diagnostics for comparison to experiment** **H1.8**
- **Coupled Core and Edge transport** **H1.2; H1.5; H1.6**
- **Edge workflows modelling SOL and interaction with PFCs** **H1.5; H1.6**
- **ELM control workflow** – including ELM module/3D MHD non-linear code **H1.2**
- **Disruption workflow** – including ELM module/RMP **H1.3**
- **Optimise predictive models for divertor/SOL** **H2.3**

WP-CD Physics applications

Integrated code development aiming at following applications:

➤ Validation and exploitation of IM workflows

- ✓ Linear MHD stability chain
- ✓ ETS (impurities, neutrals, H&CD with synergy, NTM, turbulence) + control
- ✓ feedback controlled FBE+ETS simulator

AUG TCV
MAST JET
WEST

➤ Predictive modelling of future devices

✓ FBE + ETS simulator
Baseline and hybrid scenario modelling

ITER
JT60SA

- ✓ stability chain
- ✓ FBE + control
- ✓ transport

DEMO

WP-CD short-term objectives

- **Deploy to EU Laboratories a validated ITM platform, including a suite of simplified physics modules integrated in standard workflows**
- **Train users in EU Laboratories (with CPT)**
- **Validate modules and workflows on experiments in close collaboration with MST1 and JET1 WPs**
- **Identify needs and gaps in modeling tools needed from MST, JET, JT60SA, ITER, ITPA and implement improved physics models**
- **Converge with ITER integrated modelling infrastructure**

Contact persons in Laboratories for local ITM platform support (in link with WPISA CPT)

Contact persons for maintaining machine description & datamapping

access of EU codes to ITER IMAS: Integrated Modelling Analysis Suite

Integrated Modelling development : build up on ITM infrastructure and workflows

Extension to stellarator and PWI community

→ interaction / cooperation to be set-up

– **WP-S2 : Stellarator Optimization: Theory, Development, Modelling and Engineering (4ppy)**

Topics related to Tokamaks or RFP: 3D, magnetic topology, gyrokinetics, momentum transport, NTMs, density limit, system code, ...

- **WP-PFC : Preparation of efficient PFC-Operation for ITER and DEMO**

- **Atomic and molecular data (plasma and material) validation**
- **PWI code benchmark (ERO, DUST, MEMOS, WALLDYN etc ..)**

WP-CD 2014 activities and sub-projects:



workflow development

WF development responsible = actively involved developer

1. Equilibrium & stability chain **R. Coelho / D. Yadikin**

- consolidate & package equil. + MHD workflows to apply to AUG, JET, MST:
 - Equilibrium + pedestal instability
 - HELENA – ILSA
 - J- α workflow
 - kink modes, ideal and RWM
- extend with **fast particle driven**, micro-instabilities, **edge instabilities**
- cross-verification

2. Free Boundary Equilibrium + control **C. Boulbe / J. Urban**

- cross-verification of FBE codes
- consolidate FBE + feedback control and make applicable
- FBE coupling to ETS

WP-CD 2014 activities and sub-projects:



workflow development

WF development responsible = actively involved developer

3. ETS core workflows with improved physics capability **P. Strand**

- include more transport modules (TCI including TGLF, quasilinear)
- neoclassical modules
- turbulence modules
- stiff solver
- sources : NBI, **LH**, fast ions, neutrals, runaway electrons
- verification / benchmarking with other transport codes

4. Turbulence + synthetic diagnostics workflows **A.H. Nielsen**

- SOL turbulence + probes
- core/edge turbulence + synthetic reflectometry
- benchmarking of SOL codes with MST1 data H2.3

WP-CD 2014 activities and sub-projects

~~IMP5~~ ⇒ coordinated tasks

Tasks responsible = actively involved developer

5. Heating & Current Drive **T. Johnson**

- IMP5HCD
- synergies
- build control capability
- cross-verification (under coordination of involved code developer)

6. Benchmark non-linear codes for fast-ion MHD interaction **G. Vlad**

7. EDGE/SOL coordination **D. Coster**

- core-edge coupling
 - test and consolidate
- edge codes
 - adapt I/O to CPOs / AMNS interfaces
 - edge workflows
- **SOLPS technical optimization**
- AMNS data
 - import new data /maintenance of modules

Modelling, Validation, Application of ITM workflows

! NOT in WP-CD but under MST, JT60SA, JET, DEMO

IPH: WP – MST1 Medium Size Tokamaks

Modeling for preparation and interpretation

Modelling coordination related tasks (T14)

Contact:s P. Martin, M. Beurskens *D. McDonald (CSU RO)*

IPH: WP – SA Preparation of the exploitation of JT-60SA

scenarios, MHD, turbulence/transport, fast particles, control

PL:G. Giruzzi

PPPT: WP- PMI managed by Programme Unit, RO G. Federici

application of ITM workflows to DEMO physics studies

JET: WP- JET1 Calls in 2014

WP-CD in support to MST1 modelling : workflows application to AUG

- ✓ **Equilibrium-stability workflows – pedestal stability** H1.4, H1.7
- **ETS (European Transport Simulator) workflows**
 - ✓ **providing heating and current drive profiles, as well as derived transport coefficients (direct analysis)** H1.1, H1.7
 - ✓ **with HCD and various transport models for comparison to experiment** H1.4
 - ✓ **with NTM prediction and, when ready, NTM stabilization**
 - ✓ **with Free Boundary Equilibrium and transport (start up, transition into H-mode, transition back to L-mode, ramp-down)**
 - ✓ **with HCD synergies** H2.3
 - ✓ **with coupling to turbulence**
- ✓ **turbulence workflow + synthetic diagnostics (comparison with turbulence measurements)**

WP-CD Responses to call for participation

TOTAL offered 63 ppy ! Funding available 20ppy

Physics / AMNS data / synthetic diagnostics experts / code developers → **6 workflow development and coordinated tasks**

Computational physics expertise

- SOLPS technical optimization ↔ pedestal/SOL task coordination
- ETS solvers optimization
- coupling

Infrastructure expertise → **mainly WP-ISA - CPT**

- webpage/portal maintenance
- Visualization ↔ link with CPT
- local ITM platform installation responsables in RU ↔ link with CPT

Experimental data interface

- Machine description & data mapping maintenance
- Expert of experimental database to provide experimental data for mapping, test and verification of CD codes/tools **missing MAST JET TCV !**

Physics modules still missing

- **Modules for**
 - ✓ **quasilinear transport**
 - ✓ **neoclassical transport**
 - **ELMs**
 - **sawteeth**
 - **fast particle driven instabilities, runaways**
 - ✓ **turbulence, including impurities**
 - ✓ **LH**
 - ✓ **edge/SOL transport**
 - ✓ **neutral gas transport code**
 - **Interaction with PFCs**
- **3D MHD non-linear codes**
 - **ELM**
 - **halo currents**
 - **disruptions**
 - **NTM**
- ✓ **Synthetic diagnostics for comparison to experiment**
- ✓ **3D equilibrium**

WP-ISA Infrastructure Support Activity

managed by Programme Unit: RO Denis Kalupin

ISIP + CPT ⇒ extended Core Programming Team

Team of code managers and developers, totalling up to 5 ppy,
to assist the work of the code users in the various Work Packages and
the code developers in the Code Development workpackage (WPCD)
with the following tasks:

- Functional maintenance of the Integrated Modelling platform and tools
- Implementation of new functionalities to the infrastructure
- Support to the integration of modules into workflows
- Provision of training in the Integrated Modelling infrastructure and workflows

**Team selected for 2 years
proposals from former ISIP + CPT members**

WP-ISA Core Programming Team

Deliverables 2014-2015

1. Provide support to users in the other work packages.
 - tbd
2. Develop new features, needed as the complexity of workflows increases.
 - Simulation catalogue
 - User friendly GUI
 - Maintenance and upgrades of central Kepler installation
 - Assistance in the rebuild of physics actors
 - Workflow/actor submission to HPC/GRID
 - Technical support to Data Model and Access Layer releases
3. Finalize the major restructuring of the UAL low level
4. Support to local deployment
 - documentation, training for IM platform local installation, centralized tracker support for issues raised from local installations

Timeline for implementation

Definition of the individual Associate contributions

- Selection is ongoing: PLs select the contribution of each Laboratory in close interaction with the interested RUs.
- December 4 – Proposal of allocation of activities to EFDA SC
- December 12 – Extraordinary HoRU meeting for the approval of the distribution of activities.
- Definition of the detailed work during the preparation of the Project Management Plan (Dec. 2013 - April 2014) by PLs in close interaction with the Laboratories participating in the project.
- Following the negotiation with the EC some revisions might be necessary. These will be formally adopted by the Consortium GA at its first meeting.
- Consortium agreement to be signed in the first part of next year.