Overview of project highlights

The consolidation of the validated suite of simulation tools that the ITM aims to provide for ITER and existing experiments requires a strong interaction with the experimentalists and diagnosticians fusion community. In order to provide a machine independent approach to modelling, to encompass realistic operational conditions and to facilitate verification and validation of the modelling codes, it is essential to pursue a comprehensive set of Machine descriptions, plasma control elements and synthetic diagnostic modules, covering as broad range of European fusion devices as possible. The former are promoted by the Experimentalist and Diagnosticians Resource Group (EDRG), a contact point within the ITM towards the full range of experiments.

EDRG

Overview

Consolidation of the machine descriptions (MD) and data mappings (DM) from some devices was achieved although not uniform across the full range of participating devices. While quite complete MD now exists for TS, FTU and MAST, compliant with datastructure versions 4.06d/4.07b, JET and AUG are still ready mostly for magnetics only equilibrium reconstruction application and there is no MD for TCV. This hampers a broad device testing of the ITM tools. Solid simulation runs on experimental data requires data mappings and only TS, JET and recently MAST have data valid mappings files. TS and JET MD&DM have been successfully validated with the exp2ITM tool developed by ISIP and the latter was used to retrive ~163shots from JET, presently being used for the V&V of the EQUAL code. Uneven coverage of the poloidal field systems CPO in the MD of the full set of devices is still pending and hampers free-boundary equilibrium simulation testing. A repository of the MD and DM files for each of the participating devices, useful tutorial documentation on the concept of machine description and the data mapping tools, MD processing for uploading the MD file to the ITM database and on how to fill the MD and DM XML files is cast under a md_and_dm project lying on the Gforge project management system.

Coordination of control activities was quite successful and awareness of ITM-TF activities was made to other EFDA Topical groups. Useful reports on feedback controllers used in some of the participating devices were delivered and a working session in June was organized allowing for a good assessment of the roadmap and necessary implementations to be carried out to consolidate the control activities. CPOs for profile diagnostic were assembled encompassing ECE, TS and CX diagnostics and this should assist the effort from other IMPs on the validation of their codes with plasma profile data although one should also account for importing directly experimental best fit data from integrated data analysis. Since revision of the MD is an ongoing process and effort should be made to accommodate the needs from all devices, MSE diagnostic can now encompass the effect of the radial electric field on the pitch angle calculation was made and a new set of angles definition for general line integrated diagnostics was defined, correcting a caveat in the previous definitions. Proposal for a SOL current diagnostic received and to be implemented soon.

The 3D code project ERC3D was initialised and the main modules were identified and distributed among ERCC members. Source repositories and a development

coordination website are set and a skeleton 3D code with a rudimentary wave propagation kernel was completed and initial tests were made with simple sources. Fast current density solver and more elaborated 3D finite difference (FDTD) kernel are under investigation. Interfaces to other members' modules are being prepared and spatial discretization/parallelization scalability influence on accuracy and performance are under testing. Benchmark of the 2D full-wave codes existing in the various associations.

Task status

Task-T1: Contact Person in Fusion Experiments

A. D. Muir (CCFEC)
B. C. Bourdelle (CEA)
C. O. Sauter (CRPP)
D. O. Tudisco (ENEA)
E. A. Herrmann (IPP)

Contact information from experts on profile diagnostics were obtained, facilitating development of new diagnostic datastructures. Approved MDs compliant to v4.06d/4.07b received from MAST (CCFE), FTU/FAST (ENEA) and AUG (IPP) devices. Revisions from TS (CEA) and JET approved and committed.

Task-T2: Machine descriptions and data mappings

A. D. Muir, CCFE
B. F. Imbeaux, P. Moreau, CEA
C. A. Pitzschke, CRPP
D. O. Tudisco, E.Giovannozzi, G.Calabrò, G.Ramodiga, ENEA
E. P. McCarthy, T. Lunt, IPP
F. R. Coelho, IST

Validated RUN2 versions of TS and JET MD&DM uploaded to Gforge and database entry populated. MD&DM from MAST essentially ready. MD from FTU, FAST and AUG. No DM from AUG (lack of manpower) and FTU (technical issues to be solved in remote database). Pfsystems CPO unevenly filled across the devices. First trials on 3D visualization and defeaturing tool in use at IPP.

Task-T3: Coordination of plasma control activities

A. T. Bolzonella, RFX

Feedback controllers scheme from some European devices obtained. Coordination of the ITM effort on control activities put in place and assessment made. Assessment of outreach/collaborative activities with other EFDA working groups encouraging.

Task-T4: Diagnostic related activities

A. G. Conway, IPP
B. P. McCarthy,IPP
C. M. Hellermann, FOM
D. R. Coelho, IST

MD and schemas for ECE, TS and CX diagnostics developed. SOL current diagnostic datastructure developed and filled for AUG. Coordination of the 2D reflectometer full-wave benchmarking activities.

Task-T5: Synthetic diagnostics – 3D reflectometry modelling

A. Stéphane Heuraux, Sébastien Hacquin CEA
B. Carsten Lechte, IPP
C. Emilio Blanco, CIEMAT
D. Filipe Silva, IPFN-IST

The 3D code project ERC3D was initialised and the main modules were identified and distributed among ERCC members. Creation of source repositories and a development coordination website. A skeleton 3D code with a rudimentary wave propagation kernel was completed and initial tests were made with simple sources. Fast current density solver and more elaborated 3D finite difference (FDTD) kernel are under investigation. Preparation of interfaces to other members' modules. Spatial discretization and parallelization scalability influence on accuracy and performance under testing. Benchmark of the 2D full-wave codes existing in the various associations.

Additional Comments

Publications (please keep to format!)

Journal Papers

None

Conference papers

Development of a 2D full-wave JE-FDTD Maxwell X-mode code for reflectometry simulation, F. da Silva, S. Heuraux, T. Ribeiro, B. Scott, Proc. 9th Intl. Reflectometry Workshop - IRW9 (Lisboa, May 2009), IPFN Report (nr), URL: http://www.ipfn.ist.utl.pt/irw9/proceedings.html

Selected Presentations

REPORT for TA WP09-ITM-TFL2-EDRG-T1

Reference:	Task Force: ITM Area: Task: **ITM-09-EDRG-T1**	
Document:	Contact Person in Fusion Experiments	
Author(s):	A. R. Coelho	
Date:	**25, January, 2010**	
Distribution list:	Project Leader: R. Coelho Task Force Leader: P. Strand CSU Responsible Officer: D. Kalupin	Contributors: (refer to Task Agreement) F. D. Muir (CCFE) (0.005 ppy actually committed to task) G. C. Bourdelle (CEA) (0.01 ppy actually committed to task) H. O. Sauter (CRPP) (0.03 ppy actually committed to task) I. O. Tudisco (ENEA) (0.05 ppy actually committed to task) J. A. Herrmann (IPP) (0.01 ppy actually committed to task)

Content:

Please provide

a. Task description

For the success of a fully integrated simulation environment used for discharge studies, the establishment of a close collaboration with local responsible officers from each of the participating major European experiments is envisaged. The called contact person will provide the liaison between the affiliated laboratory and the ITM and will be in charge of:

i) the coordination of the machine description (MD) and data mapping activities to be carried out in the affiliated laboratory by designated staff (see ITM-09-TFL2-EDRG-T2).

ii) the proposal of verification and validation (V&V) activities to be carried on the experimental data of the affiliated laboratory, in collaboration with the relevant IMPs of ITM.

b. Deliverables/Milestones

• A report describing the proposed V&V activities to be carried out during 2009 by April 2009.

• A report on the machine description and data mapping coordination activity by Sept. 2009.

c. Report on progress

(CCFE)

All requests for MD and DM carried out or pending. No V&V activity possible during 2009, but feasible during 2010.

(CEA)

Relayed all information requested by EDRG coordinator to the appropriate IPP specialists.

(CRPP)

Provided contacts to relevant TCV persons. Resolved open issues. Allowed machine description to be developed.

(ENEA)

Coordination of the group for the FTU Machine Description accomplishment.

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<tr><th colspan="4">REPORT for TA WP09-ITM-TFL2-EDRG-T1</th></tr>
<tr><td>Reference:</td><td colspan="3">Task Force: ITM
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Task: ITM-09-EDRG-T1</td></tr>
<tr><td></td><td colspan="3">(IPP)
Relayed all information requested by EDRG coordinator to the appropriate IPP specialists.

d. Results (particular highlights)
Coordination of the development of MD&DM files. V&V activities started on JET for the EQUAL code.
e. Outstanding issues
No V&V activities were coordinated with the exception of JET owing to lack of manpower (applies to TS) and lack of full chain MD/DM for other devices.
f. Summary paragraph
Contact information from experts on profile diagnostics were obtained, facilitating development of new diagnostic datastructures. Approved MDs compliant to v4.06d/4.07b received from MAST (CCFE), FTU/FAST (ENEA) and AUG (IPP) devices. Revisions from TS (CEA) and JET approved and committed.
g. Related Publications</td></tr>
<tr><td>Revision No:</td><td colspan="3">Changes:</td></tr>
<tr><td>Association</td><td>Written by:</td><td>Revised by:</td><td>Approved by:</td></tr>
<tr><td></td><td>R. Coelho</td><td>R. Coelho</td><td>R. Coelho</td></tr>
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REPORT for TA WP09-ITM-TFL2-EDRG-T2		
Reference:	Task Force: ITM Area: Task: **ITM-09-EDRG-T2**	
Document:	Machine descriptions and data mappings	
Author(s):	A. R. Coelho	
Date:	25, January, 2010	
Distribution list:	Project Leader: R. Coelho Task Force Leader: P. Strand CSU Responsible Officer: D. Kalupin	Contributors: (refer to Task Agreement) G. D. Muir, CCFE (0.025ppy actually committed to task) H. F. Imbeaux, CEA (0.02 ppy actually committed to task) I. P. Moreau, CEA (0.06 ppy actually committed to task) J. T. Aniel, CEA (0 ppy actually committed to task) K. A. Pitzschke, CRPP (0.03 ppy actually committed to task) L. O. Tudisco, ENEA (0.06 ppy actually committed to task) M. E.Giovannozzi, ENEA (0.08 ppy actually committed to task) N. G.Calabrò ENEA (0.08 ppy actually committed to task) O. G.Ramodiga ENEA (0.08 ppy actually committed to task) P. C. Fuchs, IPP (0 ppy actually committed to task) Q. P. McCarthy, IPP (0.1 ppy actually committed to task) R. T. Lunt, IPP (0.05 ppy actually committed to task) S. R. Coelho, IST (0.06 ppy actually committed to task)
Content:	Please provide **a. Task description** The machine descriptions are a key element in providing a device independent approach to integrated modelling. A fundamental step requires the extension of the machine descriptions, from participating experiments, beyond vessel and magnetic configurations and the associated data mapping. Completion of the present machine description aims at including: i) Heating and Current Drive systems. ii) Feedback plasma control elements (plasma position and shape controllers and actuators as well as active magnetic feedback systems for MHD control). iii) Comprehensive 3D description of the first wall, encompassing, among others, geometrical, chemical, thermal, electrical and mechanical properties and induced currents. In association with the machine description assembly, the corresponding data mapping needs to be developed. This task links with relevant tasks to be carried out by other IMPs (ITM-09-ISIP-T7, ITM-09-IMP1-T6, ITM-09-IMP1-T2b, and ITM-	

REPORT for TA WP09-ITM-TFL2-EDRG-T2	
Reference:	Task Force: ITM Area: Task: **ITM-09-EDRG-T2**
	09-IMP3-T4) and therefore expected to be carried out in coordination with the relevant IMPs. **b. Deliverables/Milestones** Development of extended set of machine descriptions and data mapping for each of the participating experiments by April 09. **c. Report on progress** (CCFE) All requests for MD and DM carried out or pending further clarification and data. First draft MD and DM documents delivered. Testing of remote database connection carried out. (CEA) The machine description and data mapping for Tore Supra, version 4.07b, have been delivered and committed to Gforge as RUN2 (later on a RUN3 was uploaded with minor updates/corrections to RUN2). Uploaded MD processing scripts on Gforge to automatically produce F90 code that creates shot=0 entry in ITM database. (CRPP) A first version of the data mapping for TCV was provided. A new version according to the new templates is being finalized (ENEA) The FTU Machine Description has been completed. Furthermore a Machine Descriptions of the FAST project (a new machine proposed as ITER satellite) has been also produced. The description of the diagnostic layout of FTU, has pointed out some inconsistency on the fields definitions that has been fixed. The rigid description of the diagnostics in the MD, however, do not fit the FTU scanning interferometer, but a good compromise has been found. The chosen structure is different from the present interferometer data organization in FTU archive, and some method to interface the FTU data needs to be developed. This has delayed the Data Mapping development. (IPP) Revision of the MD for AUG carried out. Adjustments to the flux loop (magdiag CPO) data structuring from AUG had to be made to accommodate flux loop differences. Completion of the bpol_probes element in magdiag CPO. Revision of the pfpassive element in pfsystems CPO. Revision of the MSE CPO to accommodate the effect of radial electric fields on the measurements. Machine description data for a proposed diagnostic on SOL currents delivered. Initial testing of a numerical tool for the reading and 3D visualization of CAD drawing of AUG vessel and rasterization algorithm for defeaturing the first wall details. (IST) Revision of the MD and DM files content and structuring from the participating devices. Contacts with experts on 3D defeaturing and meshing from CAD drawings (CCFE) established to understand tools/obstacles for importing a 3D mesh to a physics code. New angles definition in interfdiag CPO set. **d. Results (particular highlights)** RUN2 versions of TS and JET MD&DM uploaded to Gforge and associated database entry populated. MD files received from MAST, FTU, FAST and AUG. No DM from AUG (lack of manpower) and FTU (technical issues to be solved in remote database). Pfsystems CPO unevenly filled across the devices. First trials on

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<tr><th colspan="4">REPORT for TA WP09-ITM-TFL2-EDRG-T2</th></tr>
<tr><td>Reference:</td><td colspan="3">Task Force: ITM
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Task: ITM-09-EDRG-T2</td></tr>
<tr><td></td><td colspan="3">3D visualization and defeaturing tool in use at IPP.
e. Outstanding issues
Pfcircuits element in Pfsystems CPO still unevenly filled on set of MD files (only TS and FTU have filled it).
(CCFE)
Some MD details for bpol_probes are being acquired. Other details for pfcoils require further internal discussion with the magnetics group.
(CEA)
The work will be continued to follow the future expansion of the data structure
(CRPP)
No MD provided. Matured DM file pending.
(ENEA)
FTU Data Mapping has to be completed. Data Mapping of simulated FAST plasma is also under development.
(JET)
Interfdiag/polardiag setup missing in MD of JET. No interfdiag/polardiag/MSE data in the DM file.
(IPP)
No interfdiag diag settings in MD file (polardiag CPO not filled since AUG has no polarimetry diagnostic). No DM file yet.

f. Summary paragraph
Validated RUN2 versions of TS and JET MD&DM uploaded to Gforge and database entry populated. MD&DM from MAST essentially ready. MD from FTU, FAST and AUG. No DM from AUG (lack of manpower) and FTU (technical issues to be solved in remote database). Pfsystems CPO unevenly filled across the devices. First trials on 3D visualization and defeaturing tool in use at IPP.
g. Related Publications
Md_and_dm project on Gforge. JET and TS MD and DM Posted on ITMGforge / SVN server</td></tr>
<tr><td>Revision No:</td><td colspan="3">Changes:</td></tr>
<tr><td>Association</td><td>Written by:</td><td>Revised by:</td><td>Approved by:</td></tr>
<tr><td></td><td>R. Coelho</td><td>R. Coelho</td><td>R. Coelho</td></tr>
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REPORT for TA WP09-ITM-TFL2-EDRG-T3		
Reference:	Task Force: ITM Area: Task: **ITM-09-EDRG-T3**	
Document:	Coordination of plasma control activities	
Author(s):	A. Tommaso Bolzonella (RFX)	
Date:	**8, January, 2010**	
Distribution list:	Project Leader: R. Coelho Task Force Leader: P. Strand CSU Responsible Officer: D. Kalupin	Contributors: (refer to Task Agreement) A. T. Bolzonella, RFX, (0.33 ppy actually committed to task) B. W. Treutterer (0.0 ppy actually committed as indicated in TA)

Content:

Please provide

a. Task description

An integrated suite of modelling tools targeting the simulation of a magnetically confined plasma discharge, in realistic free boundary equilibrium experimental conditions, requires the integration of plasma feedback control elements. Specifically, plasma position and shape feedback controllers and actuators as well as active magnetic feedback systems for MHD control are foreseen in the ITM platform. A control expert is therefore called to coordinate the activities related to control within the ITM (e.g. ITM-09-IMP1-T2, ITM-09-IMP2-T4), in liaison with both the relevant IMPs and the participating experiments. The coordination of the development of a KEPLER toolbox, implemented within the ITM and dedicated to control is also foreseen. This task assumes a high level of cooperation between the relevant IMPs in order to embed a comprehensive plasma control capability within the ITM tools (ITM-09-ISIP-T12). Interaction with the *MHD Topical Group* activities on Plasma Control is foreseen. In association with the machine description assembly, the corresponding data mapping needs to be developed. This task links with relevant tasks to be carried out by other IMPs (ITM-09-ISIP-T7, ITM-09-IMP1-T6, ITM-09-IMP1-T2b, and ITM-09-IMP3-T4) and therefore expected to be carried out in coordination with the relevant IMPs.

b. Deliverables/Milestones

- Provide a report on the existing or newly developed feedback controller(s) schemes for plasma position, shape and MHD control on participating experiments by April 2009.
- Coordinate the overall plasma control ITM activities in view of a comprehensive integration of control modules in the ITM platform. This task continues through the whole 2009 year.

c. Report on progress

As first action of this task, all the PLs were contacted in order to build a comprehensive mailing list of interested people and establish an effective link between all the different activities related to control within ITM.

In the first part of the year, participating experiments were contacted and a report on existing or newly developed feedback controller(s) schemes was written. Contributions came from FTU, MAST, Tore Supra, ASDEX-U and RFX-mod; unfortunately it was not possible obtaining the full coverage of participating experiments since for different reasons (and despite several attempts) the remaining

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Task: ITM-09-EDRG-T3</td></tr>
<tr><td></td><td colspan="3">experimental groups contacted (JET, TCV and COMPASS-P) were not able to give their contributions to the report.
A working session on ITM control issues was organized in Cadarache (22-23 June 2009) with the participation of about 15 people from different Projects and from the newly constituted EFDA feedback control group. A possible workflow under the KEPLER environment for closed loop simulations was one of the main results obtained.
Participation to the EFDA feedback control group kick-off meeting (JET 29-30 July 2009) was also part of the actions aimed at broadening the overall coordination of EFDA activities in the field of control. ITM activities in the field of control were presented and possible connections with experimental issues were discussed.
During the General ITM Meeting, a parallel session on ITM collaborative efforts on control in the WP-2009 was organized and the main issues identified after the first 8 months of work were stressed in view of the 2010 control activities definition.

d. Results (particular highlights)
Feedback controllers scheme from some European devices obtained. Assessment of outreach/collaborative activities with other EFDA working groups encouraging.
e. Outstanding issues
Some contributions to the report on feedback controller schemes still missing. Delivery by the ITM of a suitable feedback control capability depends on the assessment of needs by each device.
f. Summary paragraph
Feedback controllers scheme from some European devices obtained. Coordination of the ITM effort on control activities put in place and assessment made. Assessment of outreach/collaborative activities with other EFDA working groups encouraging.
g. Related Publications</td></tr>
<tr><td>Revision No:</td><td colspan="3">Changes:</td></tr>
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<tr><td></td><td>T. Bolzonella</td><td></td><td>R. Coelho</td></tr>
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REPORT for TA WP09-ITM-TFL2-EDRG-T4		
Reference:	Task Force: ITM Area: Task: **ITM-09-EDRG-T4**	
Document:	Diagnostic related activities	
Author(s):	A. R. Coelho	
Date:	**26, January, 2010**	
Distribution list:	Project Leader: R. Coelho Task Force Leader: P. Strand CSU Responsible Officer: D. Kalupin	Contributors: (refer to Task Agreement) E. G. Conway, IPP (0.13 ppy actually committed to task) F. R. Fischer, IPP (0 ppy actually committed to task) G. P. McCarthy,IPP (0.03 ppy actually committed) H. Y. Peysson, CEA (0 ppy actually committed) I. J. Decker, CEA (0 ppy actually committed) J. M. Hellermann, FOM (0.01ppy actually committed) K. R. Coelho, IST (0.03 ppy actually committed)

Content:

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a. Task description

This task addresses the activities that are directly related to diagnostics. These play an essential role on the overall code V&V activities to be carried out in ITM, building on diagnostic CPOs and synthetic diagnostic modules. At present, Magnetic, MSE and general line integrated diagnostic CPOs have been developed and a 3D reflectometry full wave modelling framework has been identified and being pursued (ITM-09-TFL2-EDRG-T5). Therefore, a comprehensive set of CPOs characterizing diagnostic data needs to be developed to provide the necessary coverage of future V&V activities needs. In particular, *LIDAR and Thomson scattering, ECE, charge exchange, neutral particle analyser, X-ray* and *fusion product diagnostics* are requested. The opportunity for the synthetisation of the former diagnostics or for the adaptation of existing software packages to the ITM platform will be explored. A joint effort deriving out of expert diagnosticians from the participating experiments, in liaison with the ITM-TF, is expected. This task might benefit from collaboration with the Diagnostics topical group.

b. Deliverables/Milestones

- A report describing further needs and opportunities for synthetic diagnostics within the ITM by April 2009
- Definition of new diagnostic CPOs and revision of the present set by June 09.
- Adaptation of existing (if any) synthetic diagnostic software packages to the ITM framework throughout 2009 and a plan for activities for the 2010 work programme by September 2009.

c. Report on Progress

REPORT for TA WP09-ITM-TFL2-EDRG-T4			
Reference:	Task Force: ITM Area: Task: **ITM-09-EDRG-T4**		
	(G. Conway) Chairmanship of the ERCC (European Reflectometer Code Consortium) and overall coordination of the 2D reflectometer full-wave code benchmarking activities. Progress was reported at the ITM annual meeting. Expect to continue same activity and level of involvement in 2010. (P. McCarthy) SOL current diagnostic datastructure proposed (M. Hellermann) First exchange of ideas regarding the possibility to integrate the CHEAP package on the ITM-TF. (R. Coelho) Provided machine description template for ECE, Thomson Scattering and Charge Exchange diagnostics after positive feedback from R. Fischer, B. Kurzan and M. Beurskens. **d. Results (particular highlights)** MD and schemas for ECE, TS and CX diagnostics developed. SOL current diagnostic datastructure provided by IPP and filled for AUG. **e. Outstanding issues** A FEB synthetic diagnostic built in LUKE not yet an independent module/actor. No manpower to adapt CHEAP to the ITM requirements and integrate it. **f. Summary paragraph** MD and schemas for ECE, TS and CX diagnostics developed. SOL current diagnostic datastructure developed and filled for AUG. Coordination of the 2D reflectometer full-wave benchmarking activities. g. **Related Publications**		
Revision No:	Changes:		
Association	Written by:	Revised by:	Approved by:
	R. Coelho	R. Coelho	R. Coelho

REPORT for TA WP09-ITM-TFL2-EDRG-T5		
Reference:	Task Force: ITM Area: Task: **ITM-TFL2-EDRG-T5**	
Document:	Synthetic diagnostics – 3D reflectometry modelling framework	
Author(s):	A. S. Heureaux, S. Hacquin, C. Lechte, E. Blanco, F. Silva	
Date:	**08, January, 2010**	
Distribution list:	Project Leader: R. Coelho Task Force Leader: P. Strand CSU Responsible Officer: D. Kalupin	Contributors: (refer to Task Agreement) E. Stéphane Heuraux, CEA, (0.11ppy actually committed to task) F. Sébastien Hacquin, CEA (0.16ppy actually committed to task) G. Carsten Lechte, IPP (0.33 ppy actually committed to task) H. Emilio Blanco,CIEMAT, Madrid, Spain (0.33 ppy actually committed to task) I. Filipe Silva, IPFN-IST (0.33 ppy actually committed to task) J. Antoine Sirinelli, CCFE, (0 ppy actually committed to task)

Content:

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a. Task description

Following a first evaluation of the needs and opportunities for bringing synthetic diagnostic modelling into the ITM suite of tools, a 3D reflectometry full wave modelling framework has been identified and prioritised, aiming at the creation of suite of optimized joint European reflectometry simulation codes, with the prime objective being a modularized 3D full-wave code using best schemes and code parallelization techniques. This will draw upon the current ERCC (European Reflectometry Code Consortium) activity of benchmarking existing 2D full-wave codes using synthetic fluctuation input data. Operating within the ITM and Diagnostics topical group framework will assist in subsequent coupling of codes to turbulence simulation codes and aid in diagnostic development as well as help to promote fundamental physics studies.

b. Deliverables/Milestones

Algorithm prototyping, particularly the development of mixed solution schemes, for the 3D full-wave reflectometry simulation code by December 09.

c. Report on Progress

(CEA)

- Definition and Participation to the benchmark of the 2D full-wave codes existing in the various associations (presentation by S. Heuraux at the ITM meeting in Juelich in September 2009)

Participation to the development of the 3D full-wave code:

- development of a fast current density solver jointly with F. da Silva from IST Lisbon and tests of a 3D finite difference kernel. Study of the numerical stability condition on current density to find an unconditional fast stable scheme.

- tests of initial conditions for launching the probing wave

(IPP)
- The 3D code project ERC3D was initialised and the main modules were identified and distributed among ERCC members.
- Creation of source repositories (https://ipfinfo1.e-technik.uni-stuttgart.de/erc3d3d) and a development coordination website (https://ipfinfo1.e-technik.uni-stuttgart.de/ERCCwiki/index.php/Main_Page). Outlining of development rules.
- A skeleton 3D code with a rudimentary wave propagation kernel was completed and initial tests were made with simple sources.
- Preparation of interfaces to other members' modules.

(CIEMAT)
Two topics have been investigated during 2009: accuracy and performance.
The numerical accuracy can be improved if the spatial discretization of the computational domain is properly chosen. Different spatial discretizations have been studied in two-dimensions (2D). However, the implementation of free space boundaries (perfect absorbers without significant reflection) has been found to be especially difficult in geometries other than the standard rectangular grid. The reflection coefficient is significantly higher than the one that can be easily obtained in a rectangular grid. The reduction of the reflection coefficient is mandatory before these discretizations can be extended to 3D.
The performance of the code with the number of processors has been studied with a 2D code (rectangular grid). Parallelization in 2D has shown that the speed up of the code is approximately proportional to the number of processors only up to 4 processors for small/medium fusion devices (1500 x 1500 computational grid points). Increasing the number of processors increases the communications and synchronization time between them and no further reduction in the computational time has been achieved. A simplified 3D code has been recently developed to test the performance with the number of processors in 3D and to estimate the speed up that can be achieved.

(IPFN-IST)
A novel solver (JE) to handle the plasma current equation has been tried allowing a direct FDTD implementation, which constitutes an improvement over the much slower Runge-Kutta solvers, traditionally used. Such numerical scheme can be used to develop a 3D code including collision effects. The solver proved to be quite fast and accurately described the physics involved. For high turbulence values, when passing a current density limit, it becomes unstable (as the RK solvers) and with low external magnetic field can be a noisy. The study of other JE schemes is underway.

d. Results (particular highlights)

The 3D code project ERC3D was initialised and the main modules were identified and distributed among ERCC members. Creation of source repositories and a development coordination website. A skeleton 3D code with a rudimentary wave propagation kernel was completed and initial tests were made with simple sources. Fast current density solver and more elaborated 3D finite difference (FDTD) kernel are under investigation. Preparation of interfaces to other members' modules. Spatial

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<tr><td></td><td colspan="3">discretization and parallelization scalability influence on accuracy and performance under testing. Benchmark of the 2D full-wave codes existing in the various associations.
e. Outstanding issues
Some obstacles on accuracy and scalability of parallelization of 3D code. J-solvers still under investigation. No antennas datastructures yet. Details of first wall interfacing are more relevant.
f. Summary paragraph
The 3D code project ERC3D was initialised and the main modules were identified and distributed among ERCC members. Creation of source repositories and a development coordination website. A skeleton 3D code with a rudimentary wave propagation kernel was completed and initial tests were made with simple sources. Fast current density solver and more elaborated 3D finite difference (FDTD) kernel are under investigation. Preparation of interfaces to other members' modules. Spatial discretization and parallelization scalability influence on accuracy and performance under testing. Benchmark of the 2D full-wave codes existing in the various associations.

g. Publications
Development of a 2D full-wave JE-FDTD Maxwell X-mode code for reflectometry simulation, F. da Silva, S. Heuraux, T. Ribeiro, B. Scott, Proc. 9th Intl. Reflectometry Workshop - IRW9 (Lisboa, May 2009), IPFN Report (nr), URL: http://www.ipfn.ist.utl.pt/irw9/proceedings.html</td></tr>
<tr><td>Revision No:</td><td colspan="3">Changes:</td></tr>
<tr><td>Association</td><td>Written by:</td><td>Revised by:</td><td>Approved by:</td></tr>
<tr><td></td><td>ERCC Team</td><td></td><td>R. Coelho</td></tr>
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