EFDA
EUROPEAN FUSION DEVELOPMENT AGREEMENT
Task Force
INTEGRATED TOKAMAK MODELLING

Remote meeting, 10 November 2010

INTEGRATED SCENARIO MODELLING,
Introduction meeting 10 November

Presented by X LITAUDON & I VOITSEKOVITCH

TF Leader : G. Falchetto
Deputies: R. Coelho, D. Coster

EFDA CSU Contact Person: D. Kalupin

Agenda

- **Introduction**
- **I. Voitsekhovitch "Status of the modelling of DIII-D current ramp up discharges"**
- **ITPA-Joint Modelling Activity X. Litaudon**

Remote meeting

Regular remote meeting on Wednesday morning 10h30-12h00 CET (09h30-11h00 GMT) :

- **Thursday 18/11 11h-12h00 CET :**
  - Seminar of K. Lackner at IRFM with video-conference : The Role of JT-60 SA in the European Programme
- **(TF-T meeting T. Rafiq November 19, 14.00 (British time) "Drift Resistive Ballooning model for energy and particle transport at the plasma edge")**
- **Wednesday 24/11 10h30-12h00 CET**
  - Preparation of working session
- **Wed 08/12 10h30-12h00 CET**
  - Wrap-up from the working session
- **Thursday 09/12 14h00-15h Presentation of Y. Kamada-san on JT-60SA (with video-conference from IRFM)**

ISM Working session

- **ISM working session date and place have been confirmed**
  - the best compromise 29 nov- 03 Dec.
  - At Culham
  - I Voitsekovitch as Local Organiser

- **for EU invitation letter to ISM working session : send e-mail to X.L & IV**
  - CEA: M. Schneider, J. Garcia, E. Nardon, X. Litaudon
  - IPP: J. Hobirk
  - FOM: D. Hogeweij, J. Citrin
  - CCFE: J. Lonnroth, P. Belo, F. Koechl, I. Voitsekhovitch, V. Parail, L. Garzotti, D. Harting

- **ETS Code camp, scheduled for 6-17 December 2010 in Innsbruck**

ITPA-IOS: Joint Modelling Activity involve ISM

- **Modeling of ITER-like experiments on AUG, C-Mod, DIII-D, and JET (C. Kessel et al)**
- **Hybrid and Steady State rampup and access (C. Kessel et al)**
- **Modeling of ITER baseline & ramp-down simulation for the baseline scenario (V. Parail et al)**

Review of the tasks within ISM activities

- **Activity-1 : Support Validation of the ETS**
- **Activity-2 : Interpretative & predictive integrated scenario modelling on existing devices**
  - Focus on JET & ASDEX-U hybrid discharges (with & without Ip overshoot)
- **Activity-3 : Predictive scenario modelling for ITER, JT-60SA, DEMO …**
  - Focus on ITER hybrid
  - Repeat previous runs with new ECRH configuration
  - Simulation of heat transport & particle (density peaking)

Activity-1

Ref.	Task name	Start date	Involved physicist	Status/comments
ISM-P1-2010-1	Verification of ETS tool on JET ohmic pulse	March 2010	G. Pereverzev, J. Ferreira, J. Bizarro, D. Kalupin, D. Coster, I. Voitsekhovitch G. Pereverzev, J. Ferreira, J. Bizarro, D. Kalupin, D. Coster, I. Voitsekhovitch	Denis Kalupin reports on 17/09/2010- Task complete.
ISM-P1-2010-2	Verification of temperature and density transport solvers in ETS	Sept 2010	J. Ferreira, D. Kalupin, D. Coster, G. Pereverzev, I. Voitsekhovitch	
ISM-P1-2010-3	Verification of impurity solver in ETS	Sept 2010	P. Belo, I. Ivanova-Stanik, D. Kalupin, I. Voitsekhovitch	Par is contacted concerning discussion with FR about Belo's assignement to this task. SANCO runs for benchmarking.
ISM-P1-2010-4	Verification of equilibrium solver and PFDE in ETS	Sept 2010	D. Kalupin, F. Koechl, G. Pereverzev, D. Coster, I. Voitsekhovitch	VC 8/11 on coupling of free bndry equilibrium codes with transport solver

Activity-2

Ref.	Task name	Start date	Involved physicist	Status/comments/actions
ISM-P2-2010-00	Modelling of current ramp-up in JET, Asdex, Tore Supra	2008	F. Imbeaux, D. Hogeweij, F. Koechl, J. Hobirk	Revised 16/09/2010-sent to co-authors for comments 1. Prad profiles for ASDEX-U AUG22110 are required 2. TS40676 (ECCD)-repeat modeling with reprocess ECRH power 3. JET pulses repeat with Prad measurement profiles
ISM-P2-2010-1	JET DT extrapolation of the hybrid regime	August 2010	G. Sips, C. Challis, F. Imbeaux, G. Giruzzi, J. Garcia , I. Voitsekovitch, J. Henkins, TRANSP modelling, F. Kochl (Jetto), L. Garzotti, S. Wiessen, P. Belo	Presentation J. Garcia ISM meeting 29/Sept/2010 Ref. Scenario to be analysed with EDGE2D, SANCO + JETTO
ISM-P2-2010-2	Modelling of plasma rotation in Hybrid Scenario			Not started - low priority
ISM-P2-2010-3	Current ramp up JET discharges with li control.			Not started- low priority
ISM-P2-2010-4	Modelling of DIII-D current ramp up discharges (ITPA database)		I Voitsekhovitch, J. Hobirk, F. Imbeaux, D. Hogeweij, V. Parail, T Casper, D. Mikkelsen (T&C ITPA), G.L. Jackson, J.M. Park (DIII-D)	Report on status of DIII-D data and modelling 10/Nov/2010
ISM-P2-2010-05	Current ramp-up in JET Hybrid Scenario: modelling and optimisation.		E. Joffrin, J. Garcia, D. Hogeweij, F. Koechl ,	EJ proposes the following Pulses: 76858, 77933, 77922, 77914. J. Citrin modelling of 79626/79630 (with/without overshoot low delta)

Activity-2

ISM-P2-2010-06	Modelling of JET current ramp down experiments – optimisation of flux consumption and li		P. Belo, V. Parail	Not started- low priority- Modelling of HL transition with EDGE2D (divertor heat load) r
ISM-P2-2010-07	Current profile diffusion in JET hybrid scenario			Same pulses as ISM-merge with P2-2010-05 to be carried out when ISM-P2-2010-05 is finished - Includes impurity modelling and effect on performance.
ISM-P2-2010-8	ASDEX interpretative hybrid modelling	Sept 2010	. J. Hobirk, P. Belo, J. Citrin, J. Garcia, F. Koechl, J. Lonnroth, M. Schneider, I. Voitsekhovitch	Revised 17/09/2010- sent to co-authors for comments 1) AUG data in a format of ASTRA ufiles to be provided to I. Voitsekhovitch for the preparation of input PPFs for CRONOS and JETTO. 2. AUG NBI geometry to be provided for implementation to CRONOS and JETTO.
ISM-P2-2010-9	Predictive JET /JT-60U modelling of the identity experiments	Sept 2010	V. Parail, T. Tala Y. Sakamoto, P.C. de Vries, A. Salmi	Revised 17/09/2010, start during the ISM meeting Lisbon
ISM-P2-2010-10	Impurity of JET hybrid			
ISM-P1-2010-5	Validation of Edge module SOUL 1-D edge module		F. Imbeaux, V. Parail, S. Wiesen	Request of JET pulses to validate SOUL 1-D edge module + to be extended with EDG2D comparison

Activity-3

Ref.	Task name	Start date	Involved physicist	Status/comments
ISM-P3-2010-01	Migration of 2009 ISM ITER modelling to ITM-TF Gateway	Sept 2010	I. Voitsekhovitch (for technical work), all ISM members to suggest the runs, ITM expert to help with ITM conversion tools	ITER runs have been selected + TS, JET and AUG pulse list . Task complete – information sent to P. Strand on 17/09/2010 – reply on 29/09 the task is approved and complete.
ISM-P3-2010-02	Modelling of deep pellet fuelling in ITER hybrid regime	Sept 2010	B. Pegourie, L. Garzotti,…	
ISM-P3-2010-03	Modelling of the current ramp-up to 15MA baseline scenario	2008	F. Imbeaux, D. Hogeweij, F. Koechl, J. Hobirk, T. Casper	Revised 16/09/2010 and sent to involved physics 1) define the current ramp-up parameters
ISM-P3-2010-04	ITER Hybrid 0-D modelling with HELIOS			XL check with JJ
ISM-P3-2010-05	ITER Hybrid 0-D modelling with METIS			XL check with JFA
ISM-P3-2010-06	Hybrid scenario with revised ITER ECRH antenna configuration		J. Garcia, M. Schneider, J. Citrin, F. Koechl, G. Giruzzi, G. Sips, T. Casper, E. Joffrin, J. Hobirk, I Voitsekovitch	Revised 16/09/2010 sent to involved physics Waiting for ITER-IO input
ISM-P3-2010-07	Hybrid scenario with revised ITER ECRH antenna and density modelling		J. Garcia, M. Schneider, J. Citrin, F. Koechl, G. Giruzzi, G. Sips, T. Casper, E. Joffrin , J. Hobirk, I Voitsekovitch	Revised 16/09/2010 sent to involved physics Waiting for ITER-IO input

Activity 3

ISM-P3-2010-08	Integrated modelling of ITER H-mode scenario including impurities		S. Wiesen, P. Belo, F. Koechl, J. Lonnroth, V. Parail	Action : Urgent need in discussion with ITER edge/SOL experts on ITER-ISM collaboration- ISM meeting at Cadarache in 2011 ? Involve impurity experts : L. Lauro-Taroni, M. Valisa, M. Ester , C. Angioni ?
ISM-P3-2010-09	ITER hybrid current ramp-up and free boundary equilibria calculation		D. Hogeweij, F. Imbeaux, F. Koechl, E. Nardon, J.F. Artaud, , J. Hobirk, T. Casper	Optimise q-profile during ramp-up phase for Hybrid regime + Free boundary equilibrium calculation (link with F4E-Grant 255)
ISM-P3-2010-10	ITER hybrid MHD stability of scenario			
ISM-P3-2010-11	ITER hybrid real time profile q control		D. Moreau	
ISM-P3-2010-11	JT-60SA modelling			Task to be defined – XL in contact with Karl Lackner and Kamada-San

Modeling of ITER-like experiments on AUG, C-Mod, DIII-D, and JET

Background: The baseline ITER discharge is being approximated in present experimental tokamaks by matching a number of parameters such as q95, n/nGr, plasma shape LSN, βN, H98, with large bore startup, with early diverting, and with similar ramp times relative to current diffusion times. The discharge is broken into plasma current rampup, flattop and rampdown phases. These are predictive simulations of the experimental discharge, but will have varying levels of prediction relative to prescribed experimental data. There are various specific topics for modeling activities, which are listed below,

- **Modeling of rampup discharges establishing V-s savings and li evolution between ohmic and auxiliary heated discharges with various sources.**
- **Modeling rampdown discharges established in IOS 2.2**
- **Comparison of energy transport models in L-mode rampup with ITER-like experiments**
- **Comparison of energy transport models in L-mode rampdown with ITER-like experiments**
- **Modeling of entire discharges with L-H and H-L transition behavior in ITER-like experiments, generating prescriptions for ITER discharge modeling**
- **Inclusion of density transport modeling in modeling of ITER-like experiments**
- **Modeling of H/He experimental ITER-like discharges**
- **Modeling of impurity seeded ITER-like discharges**

Modeling of ITER baseline & ramp-down simulation for the baseline scenario

Background: The baseline ITER discharge is usually broken into plasma current ramp-up, flattop and ramp-down phases. In this proposal we'll concentrate on the current ramp-down phase, which includes such complicated processes as H-L transitionThere are various specific topics for modeling activities, which are listed below:

- **Modeling of rampup discharges establishing V-s savings and li evolution between ohmic and auxiliary heated discharges with various sources.**
- **Modeling rampdown discharges established in IOS 2.2**
- **Comparison of energy transport models in L-mode rampup with ITER-like experiments**
- **Comparison of energy transport models in L-mode rampdown with ITER-like experiments**
- **Modeling of entire discharges with L-H and H-L transition behavior in ITER-like experiments, generating prescriptions for ITER discharge modeling**
- **Inclusion of density transport modeling in modeling of ITER-like experiments**
- **Modeling of H/He experimental ITER-like discharges**
- **Modeling of impurity seeded ITER-like discharges**

Hybrid and Steady State rampup and access

The hybrid, or advanced inductive, experimental discharges have demonstrated that particular access conditions result in the best performing flattop configurations. The specific access approaches can be modeled in time-dependent simulations and ultimately applied to ITER simulations of the ~12.5 MA scenario. The ITER simulations would need to incorporate the requirements of long flattop burn times and V-s savings, CS/PF coil limits, and entrance to the burn phase with the L-H transition. The process for this

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- **ITER hybrid rampup and flattop simulations maintaining q(0) > 1 in ramp, with late and early H-mode transitions**
- **Collect the features associated with experimental hybrid access, JE IOS 4.1, such as early vs late heating in AUG, and Ip over-current in JET.**
- **Incorporate these features into ITER simulations, in the absence of 3D resistive MHD associated with the tearing modes present in these experiments, and combine with ITER constraints**

The steady state configuration studies on ITER are complicated by the heating and current drive sources and the transport assumptions. Time-dependent simulations for the rampup and flattop of these ITER discharges at Ip ~ 7-10 MA should be done and would need to incorporate the requirements of long flattop burn times, CS/PF coil limits, and entrance to the burn phase with the L-H transition. Access conditions identified in the JE IOS 3.2 would be collected and applied in the simulations, as well as better understanding of ITB formation or avoidance.

- **Establish a range of target configurations (flattop) based on H/CD and reasonable transport assumptions**
- **ITER steady state rampup and flattop simulations injecting various combinations of H/CD sources, with H-mode transition, transport assumptions and ITB or no ITB onset, and other ITER constraints**
- **Incorporate experimental access conditions where applicable from JE IOS 3.2**