EFDA

EUROPEAN FUSION DEVELOPMENT AGREEMENT

Task Force
INTEGRATED TOKAMAK MODELLING

INTEGRATED SCENARIO MODELLING ISM Working Session, March 11-15 2013: agenda, news from the 1st week of code camp

I. VOITSEKHOVITCH and J. GARCIA

TF Leader : G. Falchetto
Deputies: R. Coelho, D. Coster
EFDA CSU Contact Person: D. Kalupin

Agenda

Monday 11 March EFDA building, meeting room ITER A #54 (ground floor)		
10.00-10.10	Welcome, agenda, ISM WS activities, news from the 1st week of Code Camp	I. Voitsekhovitch, J. Garcia
10.10-10.40	Analysis and modelling of JET and JT-60U discharges	J. Garcia
10.40 – 11.00	Coffee break	
11.00-11.30	COREDIV capabilities for integrated core-edge modelling	R. Stankiewicz, I. Ivanova-Stanik
11.30-12.00	Modelling of the OH Ramp-Down Phase of JET Hybrid Pulses Using JETTO with Bohm-gyro-Bohm Transport	J. P. S. Bizarro
12h00-13h00	Lunch	
14h00-14h30	ASTRA-7: a state-of-the-art IPP transport code	E. Fable
13.00 – 14.00 14.30 – 18.00	Working session. Coffee break: 15.30-15.50	

Agenda

Tuesday 12 March & Wednesday 13 March EFDA building, Meeting room ITER A #54 (ground floor)		
9.00-12.00	Working session. Coffee break: 10.30-10.50	
12.00-13.00	Lunch	
13.00-18.00	Working session. Coffee break: 15.30-15.50	

Possibly training on visualization tools on Wednesday

Agenda

Thursday 14 March EFDA building, Meeting room ITER A #54 (ground floor)		
9.00 – 12.00	Working session. Coffee break: 10.30-10.50	
12.00 – 13.00	Lunch	
13.00 – 17.30	Working session. Coffee break: 15.30-15.50	
17.30 – 18.00	Benchmarking of new NBI version in ASTRA against NUBEAM /TRANSP	A. Polevoi, I. Voitsekhovitch, E. Barbato

Longer presentations can be moved from Friday to Thursday

Agenda

Friday 15 March EFDA building, meeting room ITER A #54 (ground floor)		
9.00-13.00	Reports from the week (15 min. max.)	
Coffee break: 10.30-10.50	ACT1: Impurity simulations for JET hybrid discharge with ETS and comparison to SANCO	Yu. Baranov, I. Ivanova-Stanik, J. Ferreira, D. Kalupin
	ACT1: Status of impurity simulations for JET L-mode discharges with ETS	I. Ivanova-Stanik, J. Ferreira, D. Kalupin, R. Stankiewicz
	ACT1: Predictive modelling of JET HS with ETS and comparison to experimental data	A. Figueiredo, J. Ferreira, D. Kalupin
	ACT1: Status of modelling of Hybrid scenarios for JET and ITER with ETS code	V. Basiuk, X. Litaudon
	ACT1: Effect of NTM on transport and confinement in Hybrid Scenarios	S. Nowak, V. Basiuk
	ACT1: Status of MHD stability analysis with ITM tools	F. Nabais, R. Coehlo
	ACT1: Status of ETS FREEBIE simulations	J. Urban, V. Basiuk

Agenda

Friday 15 March EFDA building, Meeting room ITER A #54 (ground floor)		
	ACT2: Turbulent transport analysis with TGLF, QualiKiz, GLF23 for JET hybrids	B. Baiocchi, J. Garcia
	ACT2: LHCD/NBI simulations for JET plasmas	E. Barbato
	ACT3: ITER scenario modelling with METIS including the real time control of the fusion burn	X. Litaudon, J. Garcia
	Act 3: Predictive density modelling with first principle models for ITER	J. Garcia, B. Baiocchi
	Act 3: ITER H-mode scenario with GLF23: impact of electromagnetic effects on fusion performance	F. Köchl, I. Voitsekhovitch
	ACT3: Coupled JETTO-COREDIV simulations for ITER H-mode scenario	I. Ivanova-Stanik, F. Köchl, R. Stankiewicz, I. Voitsekhovitch
	ACT3: Status of four field (Te, Ti, ni, Vtor) ITER modelling with ASTRA	I. Voitsekhovitch, A. Polevoi, E. Fable
	ACT3: 1D JT-60SA scenario modelling	X. Litaudon, J. Garcia, E. Barbato, E. Fable, C. Angioni
	Closing Working session	I. Voitsekhovitch, J. Garcia

ISM WS March 11-15 2013: participants

CEA:
Garcia Jeronimo (11 – 15 march 2013)
Baiocchi Benedetta (11 – 15 march 2013)
Litaudon Xavier (11 – 15 march 2013)
Basiuk Vincent (3 – 15 march 2013)

CCFE:
Voitsekhovitch Irina (11 – 15 march 2013)
Baranov Yuri (11 – 15 march 2013)

IST:
Ferreira Jorge (3 – 15 march 2013)
Figueiredo António (3 – 15 march 2013)
Nabais Fernando (3 – 15 march 2013)
Bizarro Joao (3 - 15 march 2013)

IPPLM:
Ivanova-Stanik Irena (3 – 15 march 2013)
Stankiewicz Roman (3 – 15 march 2013)

OAW:

Köchl Florian (11-15 March 2013)

ENEA:
Barbato Emilia (11-15 march, 2013)
Nowak Silvana (11-15 march 2013)

IPP-Garching:
Fable Emiliano (3-15 march 2013)

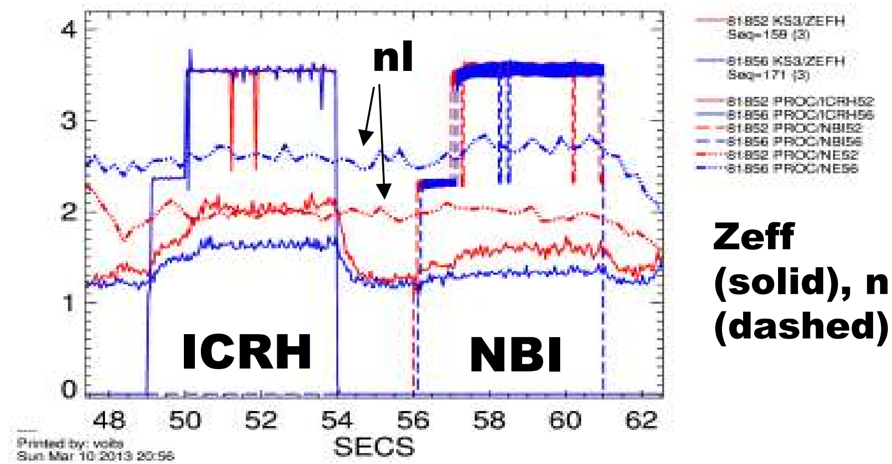
JET discharges for ETS validation

Use of these L-mode JET discharges for ETS validation under ISM/ITM has been agreed:

- **81852 and 81856: ICRH and NBI heating at different density**
- **80896 and 80889: ICRH-steps at different density**
- **83061 (56 s), 83062 (56.5 s) and 83063 (56.5 s): ICRH heating, different H concentration**

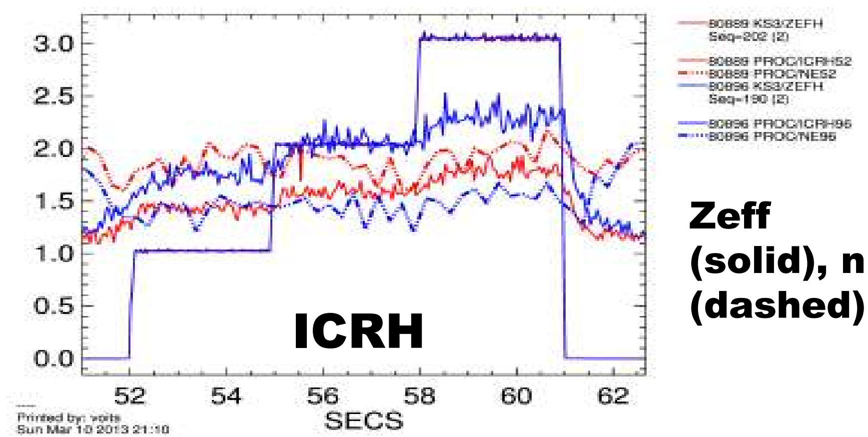
ETS experts are welcome to contribute to analysis of JET data. This analysis should be done as part of the JET work programme rather than under ISM/ITM.

81852, 81856



Zeff (solid), nl (dashed)

80889, 80896



Zeff (solid), nl (dashed)

ETS validation on JET plasmas: task description

Task objective:

validation of ETS impurity module under different experimental conditions

Requested discharges:

JET L-mode plasmas with different density, plasma heating, impurity concentration (7 discharges)

Requested measurements:

- ***ne and Te profiles***
- ***total radiative power and radiative power profile***
- ***Ni concentration, line averaged Zeff***
- ***global parameters (Btor, Ipl, a, R, shape)***

Ti measurements are not needed for this study.
TRANSP or JETTO runs needed to produce the input CPO for ETS.

ETS validation on JET plasmas: task description

Simulation protocol:

- Be, Ni and W impurity (all charge states) simulated using prescribed ne and Te profile;
- Boundary conditions:
  - Be edge density adjusted to match measured Zeff
  - Ni edge density adjusted to match measured Ni concentration
  - W edge density adjusted to match total radiative power
- Coronal equilibrium for initial and boundary conditions
- Bohm-gyroBohm model for impurity transport at the first step, then other available models will be tested

Outcome:

- simulated radiative power profile to be compared to the Abel inverted profile to estimate predictive capability of Bohm-gyroBohm model for impurity under different conditions;
- in case of good agreement: the contribution of different impurities and different charge states to the total and local radiation under different experimental conditions and Zeff profile are the main results.
- In case of disagreement – what changes in transport needs to be introduced? Under what plasma conditions?

ACT1 working groups

T2. ETS validation and application of ITM workflows to physics studies:

a. M*odelling of ITER scenarios with ETS workflows, based on the existing scenario developed with CRONOS, JETTO and ASTRA (in collaboration with IMP12, IMP3, IMP4 and IMP5)* **V. Basiuk, X. Litaudon, J. Garcia**

b. Effect of NTM on transport and confinement in Hybrid Scenarios (JET, ASDEX-Upgrade or ITER discharges (in collaboration with IMP12-ACT1, IMP3-ACT1)) **S. Nowak, O. Sauter, A. Merle, V. Basiuk, D. Kalupin**

- test/recompilation of NTM module?

- NTM simulations for JET HS 76791 and 75225, estimation of island width;

- predictive simulations with NTM module for JET shots
- simulations for AUG if data are available

ACT1 working groups

T2. ETS validation and application of ITM workflows to physics studies:

c. Core impurity transport and radiation in JET (C & ILW) and ASDEX-Upgrade (W wall) (in collaboration with IMP3-ACT1)

- JET HS 82794: CPO (*888*) from TRANSP run C01 is produced

- JET L-mode plasmas: 81856I02 → CPO created,
81852 – TRANSP run in progress

Yu. Baranov, I. Ivanova-Stanik, J. Ferreira, D. Kalupin

ACT1 working groups

T2. ETS validation and application of ITM workflows to physics studies:

d. Self-consistent (Te, Ti, ne, j) predictive modelling for JET plasmas with the ETS

- ETS simulations for 77922 with Bohm-gyroBohm model (Te, Ti, j)

- modelling for 77922 including particle transport

- test of other transport models (ETAIGB, ...)

- similar simulations for 79635 – CPO from TRANSP run is done

A. Figueiredo, J. Ferreira, D. Kalupin, V. Basiuk, X. Litaudon

ACT1 working groups

T2. ETS validation and application of ITM workflows to physics studies:

e. Equilibrium and MHD stability simulations (task continuation)

- ETS FREEBIE simulations

J. Urban, V. Basiuk, ...

- MHD stability analysis

F. Nabais, R. Coehlo, ...

ACT2 working groups

1. **Turbulent transport analysis with TGLF, QualiKiz, GLF23 for JET hybrids**

   B. Baiocchi, J. Garcia

2. **Current ramp down modelling, finalisation of publication**

   J. Bizarro, F. Koechl, I. Voitsekhovitch

3. **LHCD/NBI simulations for JET plasmas**

   E. Barbato, I. Voitsekhovitch

4. **Comparison and modelling of JT-60U and JET plasmas in typical operational domains**

   J. Garcia, B. Baiocchi, E. Barbato

ACT3 working groups

1. **Predictive density modelling with first principle models for ITER**

   F. Köchl, I. Voitsekhovitch, B. Baiocchi, J. Garcia, I. Ivanova-Stanik, R. Stankiewicz, E. Fable

2. **ITER scenario modelling with METIS including simulation of the real time control of the fusion burn**

   X. Litaudon, J. Garcia

3. **1D JT-60SA scenario modelling: implementation of the JT-60SA H&CD configuration (NBI, ECRH) in EU transport codes. Predictive scenario modelling with transport models validated in ISM-ACT2**

   X. Litaudon, J. Garcia, E. Barbato, E. Fable, C. Angioni

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1st week of code camp:

- **Training:**
  - ***general training on Kepler (http://scilla.man.poznan.pl:8080/confluence/display/euforia/Code+Camp+-+Garching+03.2013)***
  - ***IMP12***
  - ***ETS_A (installation: https://www.efda-itm.eu/ITM/html/ETS_A_KEPLER.html)***
  - ***IMP5 (https://www.efda-itm.eu/ITM/html/imp5_workflow__imp5hcd.html)***

- **Present status of ITM tools, workflows, database:**
  - ***Kepler and ETS_A are working***
  - ***ETS_C training this week?***
  - ***Compilation of database and actors is in progress***

- **Discussion of ISM requests for ETS development**

ISM requests for ETS development

1. **Modelling of time dependent scenario: all prescribed parameters should be time dependent (eg, from evolving measured profiles) (IMP3)**
   - ***All input profiles (done)***
   - ***Bt, Ipl, Zeff, plasma composition, heating powers, loop voltage, …***
   - ***a, R, shape***

2. **Neoclassical diffusion and pinch (NCLASS) for all species including impurities is urgently needed (IMP4, IMP3, IMP12)**

3. **Options for plasma composition (IMP3):**

   (a) ***- main species and impurity and simulated using transport equations***
   - Zeff and ne computed from quasi-neutrality and Zeff formula
   presently implemented option

   (b) ***- main ion density is computed or prescribed,***
   - impurity module is off, Zeff is prescribed
   - if more than one impurity – the profiles of all but one are given
   - ne and one impurity density are computed from quasi-neutrality and Zeff formula
   - radiation from coronal model
   consistency with Zeff for high charge states to be investigated

   (c) ***- ne is computed / prescribed (measured)***
   - impurities are simulated using transport equations
   - If N main ion species, N-1 densities are prescribed or simulated
   - Zeff and one main ion density are computed from quasi-neutrality and Zeff formula

4. **Shifted boundary for transport equations: Te, Ti, densities. Equilibrium and current diffusion are solved in the whole plasma volume and pedestal bootstrap current is calculated (IMP3)**

ISM requests for ETS development

5. Options for simplified description of pedestal transport (IMP4, IMP3):
- ***radial dependence to be included in prescribed D***
- ***multiplier to neoclassical transport in the pedestal region only***

6. ELM model. Actions: find the fortran version in ASTRA or JETTO

7. Library of analytical functions: Heaviside in time and radius, linear rise in time, parabolic, Gaussian, tangential (EPED), minimum/maximum for a given radial function, position of minimum and maximum, volume integral, surface integral, gradient, cut-off functions..

8. Option of using analytical function for impurity transport coefficients, H&CD sources (IMP3, IMP4)

9. Interpretative estimation of transport coefficients with prescribed profiles and heat/particle/momentum sources (IMP3)

10. Implement critical gradient model [Garbet et al, PPCF] – to test numerical problems (IMP4, IMP3)

11. Theory-based models for temperatures, particles and momentum: GLF23, Weiland, DRIBM (IMP4, IMP3)
- ***user-controlled ExB shear, alpha-stabilisation, electromagnetic/ electrostatic version.***
- ***output for fluxes of all simulated quantities, transport coefficients, growth rates and frequencies***
- ***user-controlled smoothing procedure or parameters of stable numerical scheme***

ISM requests for ETS development

12. **Heating and current drive (particularly NBI as it is main heating in present experiments) with detailed output (IMP5, IMP3):**

    - ICRH: electron and ion heating profile, heating of minority, beam ions, fast ion density and pressure profile,

    - NBI power balance: orbit, CX, shine-through losses, heat, particle and momentum sources, fast ion density and pressure. This output for each beam would be useful for scenario optimisation.

13. **Feedback of electron density with volume or line averaged, or local (central, pedestal) density, gas puff (IMP3)**

14. **Alpha-heating needed for ITER modelling (done for thermal reaction) (IMP5)**

15. **User-controlled output: possibility for user to include calculation of any variable in his private ETS workflow (characteristic lengths, gradients, H-factors, sound speed, ...):**

    - include H98, βN, li, position of pedestal, ρ*, collisionality, energy and particle confinement time, volume averaged and line averaged density, Te, Ti, ... in scenario CPO

    - or calculate these parameters as post-processing?

16. **Output for transport coefficients from different models separately (NCLASS, BgB, GLF23, etc.) (IMP4, IMP3)**