



EFDA

EUROPEAN FUSION DEVELOPMENT AGREEMENT

Task Force
INTEGRATED TOKAMAK MODELLING

Remote meeting 08 Feb 2012

INTEGRATED SCENARIO MODELLING, Introduction

**Presented by X LITAUDON & I
VOITSEKHOVITCH**

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

Agenda

**1) Introduction + IAEA/EPS Conferences X.
Litaudon**

2) ACT1/T1 ETS validation/benchmark

**2) ACT1/T2 application of ITM WFs for physics
study by I. Voiteskovitch**

Remote meeting

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

- **25 Jan 2012**
- **08 feb:**
 - Preparation Activity 1 JET K1-0-36
- **22 feb**
 - Preparation Activity 2 + 3 JET K1-0-36
- **07 march :**
 - preparation of ISM working session JET K1-0-36
- **25 Avril**
 - report from ITPA-IOS
- **09 May**
 - preparation of ISM working session
- **13 June ? To be confirmed**
- **20 June**
 - EPS contribution to ISM

➤ **First ISM working session**

- 26 - 30 March at EFDA-Garching together with the second week of the ITM code camp (focusing on ETS validation and application of ITM workflows for physics study).
- invitation letter for mobility support: **01 March**
- Our local host will be Denis Kalupin

➤ **Second ISM working session**

- 21- 25 May Vienna
- invitation letter for mobility support: **02 May**
- Our local host will be Florian Koechl

➤ **Third ISM working: mid November JET ?**

ITM Training session March 13-16 Garching

**(draft agenda to be confirmed cf G.
Falchetto)**

➤ **Tuesday AM**

- Basic ITM tools (i.e. installation of databases, write a small actor and use FC2K to integrate it to Kepler, use of Catalogue Querying Tool) CPT half day
- ISE demonstration and practice

➤ **Wednesday**

- Visualisation tools (Python,...)
- How to create an actor from a C program how to debug a workflow

➤ **Thursday**

- Equilibrium chain W. Z.
- ETS_A Friday
- How to use the AMNS interface
- General Grid Description and Grid Service Library
ETS_C

Participation to first ISM Working session 26 - 30 March at EFDA-Garching

- **CCFE**
 - I. Voitsekhovitch
- **CEA**
 - X. Litaudon , V. Basiuk
- **Swedish Euratom-VR**
 - Sara Moradi 12-23 March (General Training on ITM tools and workflows and first 2012 Code Camp)
- **EPFL**
 - O. Sauter
- **ENEA_CNR**
 - Silvana Nowak
- **IPPLM**
 - Irena Ivanova-Stanik, R. Stankiewicz

2012 ISM working sessions

January

Mo	Tu	We	Th	Fr	Sa	Su
30	31					1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

February

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27	28	29				

March

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April

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May

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28	29	30	31			

June

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25	26	27	28	29	30	

July

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16	17	18	19	20	21	22
23	24	25	26	27	28	29

August

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27	28	29	30	31		

September

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24	25	26	27	28	29	30

October

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29	30	31				

November

Mo	Tu	We	Th	Fr	Sa	Su
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26	27	28	29	30		

December

Mo	Tu	We	Th	Fr	Sa	Su
31					1	2
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24	25	26	27	28	29	30

2012 EPS Conferences other proposals ?

- **“Integrated modelling for tokamak plasmas: from baseline to advanced performance” (summary of ISM work: H-mode + HS, ACT1-3)**
 - I. Voitsekhovitch et al
- **Comparative transport analysis of JET and JT-60U discharges**
 - J. Garcia et al
- **Integrated modelling of JT-60SA scenarios with the METIS code**
 - G. Giruzzi et al
- **“Simulations of density profiles in JET hybrid discharges”**
 - L. Garzotti et al
- **Real time control hybrid ITER scenario**
 - F. Liu et al
- **LHCD simulations by ASTRA/FRTC in JET discharges**
 - E. Barbato et al
- **Free-boundary equilibrium transport simulations of ITER hybrid scenarios under control**
 - J. Urban et al

2012 IAEA Conferences other proposals ?

- **Modelling of Hybrid Scenario: from present-day experiments toward ITER (ISM)**
 - X. Litaudon, I. Voitsekhovitch et al
- **Model validation and integrated modelling simulations for the JT-60SA tokamak**
 - G. Giruzzi et al
- **The European Integrated Tokamak Modelling (ITM) effort: achievements and first physics results**
 - D. Kalupin, G. Falchetto et al
- **Integrated Magnetic and Kinetic Control of Advanced Tokamak Scenarios on DIII-D Based on Data-Driven Models**
 - D. Moreau (mainly ITPA DIII-D + ISM for ITER part)
- **Other proposals not related to ISM**
 - V Parail ITER scenario (3 scenarios) modelling Grant 255

IAEA- ISM overview : title & co-author

➤ Modelling of Hybrid Scenario: from present-day experiments toward ITER

- X. Litaudon¹, I. Voitsekhovitch², J.F. Artaud¹, P. Belo³, J. Bizarro³, T Casper⁴, J. Citrin⁵, E Fable⁶, J. Ferreira³, J. Garcia¹, L. Garzotti², J. Hobirk⁶, G.M.D. Hogeweyj⁵, F. Imbeaux¹, E. Joffrin¹, F. Koechl⁷, J. Lönnroth⁸, F. Liu¹, D. Moreau¹, V. Parail², Ph Snyder⁹, M. Schneider¹, ASDEX Upgrade Team, JET-EFDA contributors , and the EU-ITM ITER Scenario Modelling group**

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IAEA - ISM overview : Objectives

➤ **Objective**

- **overview of the recent European modelling effort carried out within the Integrated Scenario Modelling group**
- **understanding the underlying physics of the hybrid regime in ASDEX-Upgrade and JET under different experimental conditions (plasma shape, heating power, plasma current ramp-up waveform, dimensionless parameters etc)**
- **extrapolating them toward ITER**

IAEA - ISM overview :

Main results/conclusion

- **Interpretative and predictive analysis of 6 JET and 5 AUG hybrid discharge (CRONOS, JETTO , ASTRA)**
 - JET: 77922, 79626/79630, 77280 (20 s discharge) 77933, 76858 & two AUG(20993/20995)
 - Current diffusion using neo-classical prediction for the resistivity and bootstrap current is simulated for JET and ASDEX-U
 - The correlation of the improved confinement with a higher volume average s/q ratio observed in low triangularity consistent with GLF23 model (s/q effect). This effect accounts for ~60-90% and ~35-55% of the core confinement improvement in JET and ASDEX-Upgrade [J. Citrin et al, submitted to PPCF]
 - Accuracy of the Bohm/gyro-Bohm and GLF23 models to predict the characteristics of heat, particle and momentum transport has been estimated for the simulated JET and ASDEX upgrade hybrid scenarios.
 - The termination of the JET hybrid discharges with the transition from the hybrid performance either to the H-mode plasma with subsequent H-L transition or straight to the L-mode plasma has been analysed, allowing determination of the back-transition conditions [P. Belo, et al, Proc. EPS conference 2011]

IAEA - ISM overview : Main results/conclusion

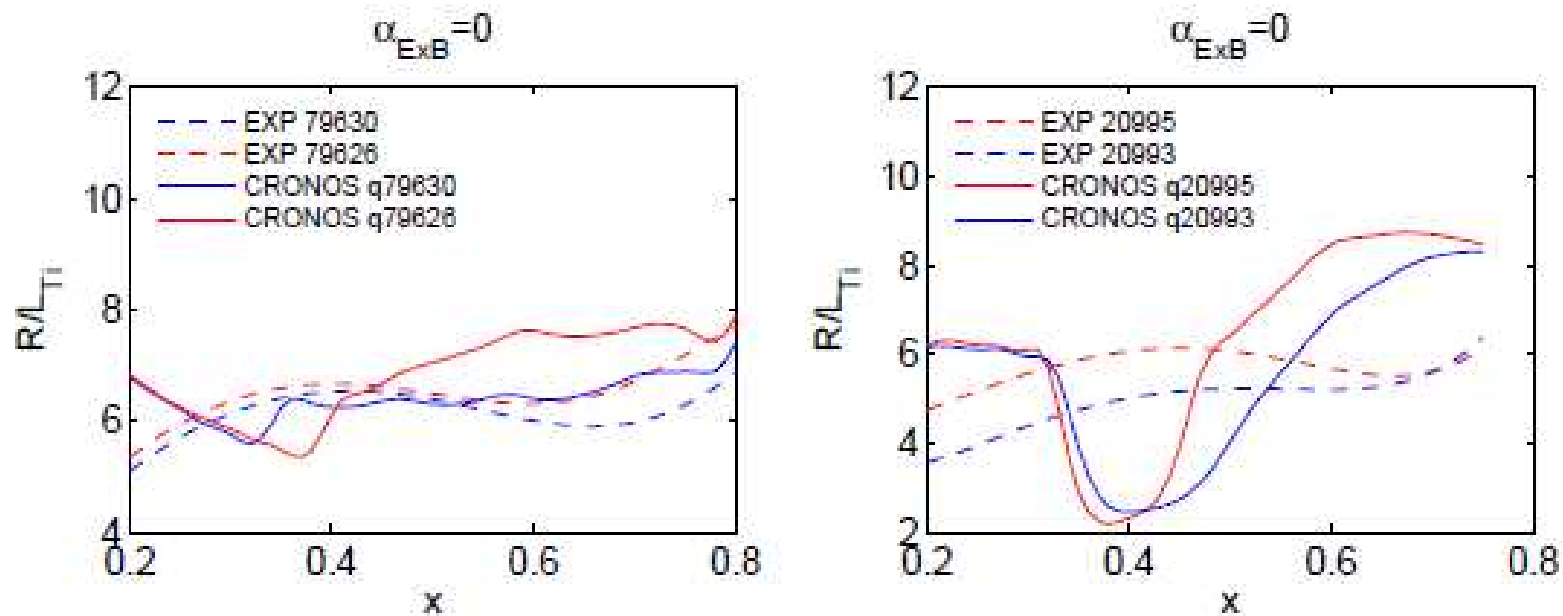


Figure 1: Comparison of R/L_{Ti} GLF23 predictions following q -profile substitution. Results are shown for the JET pair (left column) and the AUG pair (right column).

IAEA - ISM overview : Main results/conclusion

➤ **Projection towards ITER**

- **access condition to the class of hybrid-like q-profiles (i.e. flat in the core with q above 1) during the current ramp-up** [G.M.D. Hogeweij et al, Proc. 21st Int. Toki Conference (2011)]
- **The EPED pedestal model** [P.B. Snyder et al NF 51 103016 (2011)] **validated on a database of JET hybrid scenarios has been applied to ITER hybrid scenarios. Prediction for the pedestal height and width at various plasma currents ($I_p = 11, 12, 13\text{MA}$), effective charge and pedestal density ($n_{\text{eped}} = 6.5 - 10.5 \times 10^{19} \text{m}^{-3}$). pedestal pressure ($\beta_{N,\text{ped}} \sim 0.6 - 0.8$) and width ($\Delta_{\psi\text{ped}} \sim 0.04 - 0.045$)**
- **Main scenario with EPED constrain + optimised q-profile using GLF23** [J. Citrin, et al, Nucl Fusion 50 (2010) 115007]
- **real time control model based algorithm applied to ITER hybrid regime** [D. Moreau et al 2011 Nucl. Fusion 51 063009]