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RT-11: Analysis and modelling of JET data before C45

D. Keeling

On behalf of WPTE TFLs

E. Tsitrone, N. Vianello, M. Baruzzo, V. Igochine, D. Keeling, A. Hakola, B. Labit

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RT-11: “Analysis and modelling of JET data before C45”

- We remind you that much of the JET experimental programme in 2022/23 was carried out under the RT22-01 – 09/RT01 – 09 structure
  - Ongoing analysis of such experiments should be proposed under the appropriate RT01 – 09
- For 2025, RT-11 has been expanded cf. 2024 with two scientific objectives:
- D1: Continue the analysis and modelling of the JET experiments related to DTE2
  - This aims at completing analysis related to DTE2 experiments and any continuation in C44, C45, C46/DTE3, C45B
  - Since such experiments were started in DTE2, they are considered, as the title suggests, “JET data before C45” even though the experimental work may have continued to the end of 2023
  - Generally speaking, such proposals should quote the experiment ID they are contributing to (M18-*/M21-*)
- D2: Data analysis and modelling in support of ITER/DEMO not otherwise related to D1 or RT-01 to 09
  - This objective recognises the resource that the JET database represents and that analysis may be performed in support of ITER/DEMO in a way not directly related to any of the experiments that produced the data.
  - Such proposals must state in the work-plan how it will support the ITER re base-lining, the ITER research plan and/or ongoing ITER/DEMO design activities.

Ongoing Analysis

- There has been recent correspondence between TFLs and previous experiment SCs and topic leads to ascertain a list of A&M activities that will be ongoing in 2025
- The purpose here is to define a number of high-level expts/topics to enable co-ordination of work-plans and proposals. Wiki pages for each of these have been set up (https://wiki.euro-fusion.org/wiki/WPTE_wikipages:_Experimental_campaign_2025:_RT11)
- We remind you that this structure has been set up for convenience of co-ordinating these activities but that you are not limited to making proposals under these heading – D2 makes clear that any proposal utilising JET data supporting ITER/DEMO will be considered

High-level topics/ experiments

Experiment/Topic	Area of study	Principal contact(s)
M18-14/M21-14	L-H Transition	Emilia Solano
M18-24	Dimensionless transport	Tuomas Tala
M21-01	Hybrid-mode scenario in DT	Athina Kappatou, Jorg Hobirk, Ernesto Lerche
M21-02	T-rich beam target scenario	Mikhail Maslov
M21-03	Baseline scenario in DT	Dirk van Eester, Luca Garzotti, Vito-Konrad Zotta, Domenico Frigione
M18-27, H16-09, M21-15	Detachment and density limit in DT and ^{4}He L-mode plasmas	Mathias Groth
M18-05, M21-17, RF topics	2nd Harmonic heating of T in DT	Mervi Mantsinen, Philippe Jacquet
DTE2-05 and 06		
M21-05	3-ion RF scenarios	Massimo Nocente, Yevgen Kazakov
ITB Group	ITB formation in TT/DT plasmas	Costanza Maggi
C43/He campaign	RT-He-01 to 05 (+RT-05+M21-17)	Various (see wiki pages)
M18-08	Impact of fuelling and pacing pellets on SOL and pedestal	Christian Perez von Thun

M18-14/M21-14: L-H transition

SC/Principal contact(s): Emilia Solano

- Investigate dependence of L2H and critical profiles on configuration, plasma content, heating, etc
- Investigate how isotopic content and operating conditions (configuration, GIM selection, feedback vs feedforward, seeding, Hybrids vs Baseline…) affect the dynamic evolution of profiles after the L2H transition, both with slow power ramps and with conventional scenarios
- Relation between ne,sep, Te,sep and critical profiles, plasma states, PLH
- Ion heat flux analysis of pure T shots (DT finished in 2024)
- Analysis of impurities on L2H and H2L transition
- Refine power threshold scaling studies (JET and multi-machine)
- Use L-mode database on confinement as basis to investigate power threshold trends
- Create database of JET L2H and H2L transitions in most shots with automatic detection tools, adding M-mode detection. Exploit results.
- Gyrokinetic simulations: PLH dependence on isotope content (pure D vs 50% H 50% T, also D, DT, T scan)
- Interaction with TSVV-1 team on influence of plasma equilibrium details on L-H transition conditions
- Interaction with DEMO and ITER team on influence of JET results on operation and design choices.
- Edge-SOL characterization with kg8c diagnostic: evolution of Er and turbulence levels across the L-H transition for the different plasma conditions, across Bt scans, dependence on ion mass and expand investigation of dithering L-H transitions, tracking evolution of Er, turbulence, GAMs, and density profiles along the L-H-L cycle.
- **Potential participants asked to contact Emilia as a matter of urgency**

M18-24: Dimensionless Transport

SC/Principal contact(s): Tuomas Tala

- Following talk at the AAPPS-DPP2024 conference on isotope scaling between D and T, plan to progress the analysis to the phase where topic can be concluded and paper written
- For experimental analysis, modulation analysis by named contributors will be required
- Also requires effort from GENE and TGLF side, also by named contributors
- Complete RT-He-02 experiment analysis

M21-01: Hybrid mode scenario in DT

SC/Principal contact(s): Athina Kappatou, Jörg Hobirk, Ernesto Lerche

- Aim to complete analysis of H-mode entry phase of D and D-T hybrid mode plasmas
  - Looking at effects of H-mode entry at marginal P/P_LH cf. significant margin
  - Integrated core-edge modelling (ASTRA/TGLF)
  - Comparisons DD ←→DT

M21-02: T-rich beam-target scenario

SC/Principal contact(s): Mikhail Maslov

- Analysis and modelling to understand / quantify the differences between the T-rich scenario and the 50:50 D:T scenario using N=1 D ICRH using the ETS H&CD workflow; This is based on 2 H-mode and 2 L-mode pulses and requires data validation, TRANSP runs and H&CD interpretative ETS runs for several time points.
- Predictive H&CD ETS runs to confirm efficient ion heating and general prediction capabilities of the ETS6 transport modules. (overlap with TSVV work package)
- Gamma and neutron spectrometer analysis using synthetic diagnostics based on ETS distribution functions
- Integrated modelling of core transport in T-rich scenario including high-Z impurities (numbers very approximate, depends on the progress before Xmas)
- Data analysis and interpretation of correlation reflectometry (KG8c) measurements

M21-03: Baseline scenario in DT

SC/Principal contact(s): Dirk van Eester, Luca Garzotti, Vito-Konrad Zotta, Domenico Frigione

- Complete coconut simulations of 3-4 relevant shot for the experiment, including new shots performed in 2023
- Complete impurity analysis for the shots to be analysed
- Pedestal stability analysis to be performed (fitted input profiles are ready but resources have been scarce as mainly deployed on other high priority shots).
- Complete estimate of radiation patterns.
- Complete data validation.
- Complete investigation of sputtering due to ELMs.

M18-27, H16-09, M21-15: Detachment and density limit in DT and ^{4}He L-mode plasmas

SC/Principal contact(s): Mathias Groth

- Physics of the density shoulder formation in JET-ILW H, D, T and D-T L-mode plasmas (collaboration with Alexander Thryso of DTU, Niels Horsten)
- Impact of photon transport on detachment in JET-ILW H, D, T and D-T L-mode plasmas (Ray Chandra)
- Effective pumping speed in H, D and T gas injection calibration pulses (in collaboration with Ionut Jepu -> M.Sc. thesis of Aaron Vesa, Aalto University)
- Tungsten and nickel sputtering during the limiter phase in JET-ILW D, T and D-T plasmas (M.Sc. thesis of Pyry Virtanen, Aalto University)
- Ammonia formation in JET-ILW H, D and T plasmas (PhD thesis of Roni Maenpaa, Aalto University)

M18-05, M21-17, RF topics: 2nd Harmonic heating of T in DT

SC/Principal contact(s): Mervi Mantsinen, Philippe Jacquet

- Finalize the analysis and modelling of experiments M18-05/M21-17 (including experiments carried out in DTE3) on:
  - He-3 minority heating and
  - second harmonic heating of T
- Prepare a journal publication on DTE3 results and extrapolation of the results to ITER

DTE2-05 and -06: Confinement and transport in mixed DT plasmas

SC/Principal contact(s): Philip Schneider

- Analysis of divertor and SOL measurements to understand the separatrix density
  - Interested in running EIRENE analysis
- Analysis and modelling of the ELM stability and post ELM recovery in terms of transport and resistive peeling ballooning stability (ASTRA, TGLF, MISHKA, ELITE, CASTOR)
- Modelling of core transport to understand the cause the shortcomings of quasilinear models, particular, at high betaN (GENE, ...)

- Estimate ~6-8 pm required divided between 2-3 people with required modelling skills

M21-05: 3-ion RF scenarios

SC/Principal contact(s): Massimo Nocente, Yevgen Kazakov

- 3-ion RF scenarios are novel ways to utilise an additional plasma species or impurity to achieve RF plasma heating with tailored heating profiles and FI energy distribution
- Tested extensively on JET in 2021-23 including use of ^{3}He and ^{9}Be species

- To be done in 2025:
  - Finalize the analysis and modelling of experiments M18-05/M21-17 (including experiments carried out in DTE3) on He-3 minority heating and second harmonic heating of T including preparing a journal publication on DTE3 results and extrapolation of the results to ITER

ITB group

SC/Principal contact(s): Costanza Maggi

- During the TT/DT campaigns it was noted that there appeared to be an isotopic effect on the formation of ITBs
- ITBs were notably present in M21-09 (alpha physics) and M21-01 (hybrid-mode scenario) plasmas.
- This group was set-up to study the ITB phenomenon and determine the isotopic role in formation and sustainment of ITBs.

- Principal A&M requirements:
  - TRANSP
  - Core transport & ITB modelling
  - Core W transport modelling
  - GK modelling of pedestal
  - Core GK modelling

M18-08: Impact of fuelling and pacing pellets on SOL and pedestal

SC/Principal contact(s): Christian Perez von Thun

- Pulses obtained during the post-DTE3 phase of JET in 2023 – analysis still to be completed
- Reminder of experiment deliverables:
  - D1. Perform systematic, well-diagnosed scan of pacing pellet characteristics and determine impact on SOL, pedestal, ELMs, and plasma performance for DT scenario plasmas.
  - D2. Compare use of GIMs and TIMs for effect of gas fuelling in DT scenario plasmas, including documenting SOL plasma for validating physics based edge models.
  - D3. Validate physics based edge codes and use to predict integrated high performance plasmas in support of the preparation for DT
  - Back-up part of the experiment:
  - D4.Determine experimentally impact of fuel injection location on divertor and edge conditions in L-mode and on access to high performance H-mode

RT-He-01 to 05

- The C43 Helium campaign on JET comprised 5 dedicated research topics:
  - RT-He-01: ELMy H-mode operation in He in view of the non-active phase of ITER --> scenario development
  - RT-He-02: Qualifying transport in the core and edge of helium plasmas, in preparation of the non-active phase of ITER
  - RT-He-03: ELM control in helium H-modes for the non-active phase of ITER
  - RT-He-04: Helium plasmas for understanding detachment physics
  - RT-He-05: Assessing plasma wall interactions in He plasmas in view of the non-active phase of ITER

- Bids for participation aimed at completing any outstanding analysis for these topics is welcomed
- Please speak to the relevant RTCs/SCs for co-ordination of this effort.

Other proposals

- Preceding pages list continuation of analysis of M18-*/M21-* experiments that TFLs have been made aware of
- We emphasise that proposals are not limited to these (see the text of the call for participation, D2) and any analysis of JET data in support of WPTE aims will be considered.