WPSA Code Management and Modelling Area - 2022 summary

WPSA General Meeting, 4-6 May 2022

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WPSA Code Management and Modelling area strategy

➤ Establish **reliable modelling codes**, **workflows** and **operation related tools** for routine use in JT-60SA scientific exploitation

➤ **Modelling support to the enhancements and diagnostics** procured by EU

➤ Specific focus on **modelling the Initial Research Phase** + contribute to Integrated Research Phase wall diagnostics design (F4E/WPDIV)

	Phase	Expected operation schedule		Annual Neutron Limit	Remote Handling	Lower Divertor (wall material)	P-NB Perp.	P-NB Tang.	N-NB	NB Energy Limit	ECRF 110 GHz & 138 GHz	Max Power
Initial Research Phase	phase I	2020-2023	H	-		-	0	0	0	0	1.5MW x5s	1.5MW
		2025		(N2)			3MW	3MW				19MW
	phase II	2025	D	3.2E19 (N2)	R&D	Carbon Div. Pumping (Carbon)	6.5MW			23MW x 14s duty = 1/30	1.5MWx100s + 1.5MWx5s	26.5MW*
		2026										
	phase III	2027										33MW*
Integrated Research Phase	phase I	2029 - 2032	D	4E20 (water)		Actively cooled Carbon Div.Pumping (10MW/m2 ss, 15MW/m2x5s) (Carbon)	13MW	7MW	10MW	20MW x 100s 30MW x 60s duty = 1/30	7MW x 100s	37MW
	phase II	2033 -	D	1E21 (water)	Use	Actively cooled Tungsten Div.Pumping (Tungsten)						
Extended Research Phase		>5y	D	1.5E21 (Boron)		Actively cooled Tungsten Advanced Structure (U. Div. to be considered) (Tungsten)	16MW	8MW		34MW x 100s		41MW

(filler in the VV double wall)

Upper Open Carbon Divertor (very limited heat handling capability) is always ready

*Real Injection: ~ 26MW x 2-3 sec limited by divertor cooling

Updated Project Phases
BA SC 29

Progress towards the deployment of validated modelling and analysis tools for operation and scientific exploitation

❖ **Discharge Simulator**

    Actions: work with QST on feasibility of the scenarios in the PID

        ➢ test cases data list & links on wiki

        ➢ output data in IMAS for use by other codes/workflows

❖ **Scenarios**:

    LG: EC frequency used in Research Plan to be revised? shoudl be ok with steerable ECH launcher

    JG suggestions:

        • assess if auxiliary power enough to access H-mode in H – extrapolated to D – to help ITER

        • shinethough addressed in JINTRAC? it was estimated in the past

        • assess if enough ECRH power to tailor the q-profile? Egrelevant for hybrid scenario 4.2

    GP: which resistivity used? Impact on ramp-up. Neoclassical? Spitzer?

        effect of ramp up speed on the profile? Relevant for hybrid scenario

        reversed q –profile during EC deposition ?

    In ETS: effect of impurities? Can affect ramp up.

    Actions:

        ➢cross verify output profiles from JINTRAC/ETS to provide unique IMAS/IDS data for eg EP stability calculations

        ➢modelers/TGLs provide requests for more advanced modelling if needed

            • use ASCOT instead of PENCIL for NBI

            • assess QL models for L-mode eg use TGL **2022 deliverable**

❖ **WPDIV**   **Needed data from the modeling** (WPSA):
  - **Pumping efficiency (W vs C)** (2023) -> **definition of the target geometry**
  - **Assessment of the neutron activation** (2023) -> **definition of the structural material**
  - What is the **surface shaping** needed (2024) -> **choice of the armor material** (machining tolerances) and **final drawing**

❖ **Edge/SOL modelling**   **Requirements:**
  - Magnetic equilibrium (including divertor legs) and wall data (chamber + subdivertor)
  - Machine Data : puffing valve positions and available gases, auxiliary heating power
  - Power and particle flux through the inner simulation boundary
  - Reliable prediction of transport based on
    1. Experimental findings and previous simulations from C-wall JET
    2. Estimations from core and pedestal modelling
    3. Existing scalings

- SOLEDGE activate drifts ?
- SOLPS-ITER Ar puffing modelled
  - Peter Lang : what about modelling Ar from the inboard? Eg by pellet (different then puffing from core) which is found to radiate more efficiently
    – Balbinot: Ar puffing location studied with SOLEDGE : puffing from dome lead to detachment at lower density
    – Rubino: tested in SOLPS-ITER on Nitrogen – woudl need to recover old data
- SOLPS-ITER benchmarck
➢ contact with Yamoto san need be re-established to analyze discrepancies on D case and get SONIC results from case with C

❖ **Energetic Particles**
- Investigate differences in EP stability btw Scenario 2 and high density
  EP studies ITER relevant very important if fast ions do or not drive the (TAE?) modes

❖ **RWM control**
- Sensistivity scans over some paramaters
  - Interesting to know what limits the scenario eg NBI power ? Beta?

❖ **ELMs –pellets**
- Investigate topics for collaboration using MIPS code (Suzuki san) – synergetic not superposing to his RMP –ELM stabilization studies
- PB + gradients complex interplay with current on ELM triggering; also depending on injection time of the pellet
  - Stronger pellet shading on JT-60SA?
- Use more realistic parameters (eg resistivity) in JOREK
- Comparison of physics models eg Resistive MHD in JOREK vs MIPS could be interesting

❖ **MHD stability chain**
- Can address the resistive infernal mode or PB with resistivity?
- ➢ Investigate an extension of the wf with calculation of delta'
- ➢ Investigate (feasibility/resources) of implementation of MARS-F or CARMA in the chain
  Actions Provide the analysed scenarios cases / data outputs
  identify interested test users and set up dates for a training

❖ **IDAV**

➢ A good connection with diagnosticians is required 1ppy/y appears as a very small manpower for the considered work

- Tool is meant to be used in intershot analysis
- Use of raw data is preferred but also treated data eg with calibration included is usable
- Equilibrium is also included uncertainty can be provided

➢ Investigate inclusion of 3D equilibrium

➢ Is IDAV able to take into account fast events or only usable in steady state? Eg eddy currents, noise of ECE?
- In AUG 1ms time scale equil reconstruction, diagnostics sampling rates (MHz, GHz) fast enough
  - There might be issue for ELMS

- **NEXT STEPS**
➢ Detailed presentation and dedicated discussion in specific working group is foreseen under ET

➢ EEG project proposed if not selected by EF, possibly submit a project for ERG

❖ **TPCI**
- Synergy with BES synthetic diagnostics

Action investigate sharing of GENE simulations- as backgroud fluctuation data

❖ **FILD**

Action interact with scenario modelling Task coord.: scenarios from JINTRAC with ASCOT available

❖ **ECWC**
- Needed input data: EDICAM tomography
- Density profile wished at some locations for crosscheck if possible

❖ **Camera tomography**
- EDICAM raw data access required

❖ **Breakdown modelling for IC**
➢ BD very sensitive to error fields can this be investigated?
- 3D currents in the passive structures negligible

❖ **Breakdown simulator**
➢ Include impurities in the prefill? Yes foreseen with different impurities and C
➢ Influence of different absorption layer ?

❖ **RE impact on PFC**
➢ Use equilibrium including RE

❖ **RE detection by camera tomography**
Open points on possibility of detection on JT-60SA
- RE energy range ? RE radiate in visible?
- EDICAM view is co current ?
- Asymmetries?
- reflections
➢ Inversion method?
Actions EB GF organize dedicated meeting on RE: with all experts/interested

❖ **Disruption DB**
  ➢ Sergei : main question is the definition of what is a disruption
  Actions: disruption WG MHD TGL G Pucella
  - Resume contacts with QST
    – Agree on database
    – Support/responsibility to collect data & check the data quality?
    – Resources for infrastructure implementation

❖ **Disruption trigger**
  ➢ **Eva:** need is a very simple tool for control room – run on previous shots for confidence
  ❖ **CIEMAT proposal**
    ➢ Will there be locked mode signal in JT-60SA?
    - It si noted that locked mode is not a disruption trigger fro MGI but information on plasma in ill conditions
    - Use locked mode signal normalized to plasma current? More physical meaning
  ❖ **ENEA IAP indicators**
    - Indicator on magnetics: is there a threshold? On pulse calibration it is a statistical method
    - MARFE not necessarily leads to disruption : threshold? Use with supervision
  ❖ **NTUA proposal**
    - JET C wall appropriate large database available (as a note not much C in JT-60SA at IC)
    ➢ transfer learning to another machine data, so to be able to have a trigger ready when JT-60SA data available

  Action JV organise task work progress meeting

❖ **Disruption EM force modelling**
    Needs of data from IC for validation of CARMA0NL

**Thank you all
for your active participation
& highly informative presentations
Thanks to ETL TGL
for pertinent inputs and discussions**

Beyond the research plan: Exploratory ideas

JT-60SA

- Is central heating in JT-60SA enough at high density?
- Would more ECRH be required?
- Is ICRH a possibility for JT-60SA? What would be its impact?
- Can experiments be proposed in European tokamaks to address JT-60SA physics?
- Is the strong electron heating a problem for confinement in JT-60SA?
- Is it needed a full assessment of transport & confinement in L-mode plasmas?

Please keep your Task wikipage up-to-date

- https://wiki.euro-fusion.org/wiki/WPSA:_Code_Management_and_Simulation

- The **EUROfusion Gateway** cluster is the home of WPSA code development work and shared simulation tools

- **Gateway access request** please follow the procedure on: https://wiki.eufus.eu/doku.php

- Gateway login (X2Go, NoMachine, ssh) g2username@login.eufus.eu

- A training on the Gateway setup and use (as well as on IMAS) provided by ACH is available, links on:
  https://wiki.euro-fusion.org/wiki/ACH-04

- A **gitlab** has beeen setup: https://gitlab.eufus.eu/

- A repository for WPSA Gateway users has been created : **/afs/eufus.eu/gw/wpsa**
  you can request access to admins: mail to rcoelho@ipfn.ist.utl.pt; CC gloria.falchetto@cea.fr
- Previous JT-60SA modelling data is stored here:
  /afs/gw/wpsa/groupoffice/users/MODELING

- Documentation tutorials on discharge simulator METIS / CREATE_EGENE
  - https://wiki.euro-fusion.org/wiki/WPSA_CM:_Discharge_simulator
- Gateway repository : /afs/gw/wpsa/applications/

WPSA.CM Next steps

➤ Interaction with QST/ET to acquire the reference data needed for modelling

➤ Task work progress meetings, involving TGLs as relevant for future planning/focus

➤ KOM for new tasks:
  - Dedicated meeting on edge/SOL modelling support to Langmuir probe design assessment
    (WPSA CM ENH reporting to WPDIV F4E)
  - Dedicated meeting on RE modelling / detection (WPSA CM OP ENH TGL)
  - FILD modelling

➤ Planned contributions to conferences/publications? Inform WPSA PL remember to priorly upload on EUROfusion Pinboard
  Joint publications with QST encouraged

❑ General Planning Meeting (Budapest) – September
  - Parallel session on modelling – remote attendance also possible

➤ Deliverable reports due by December 2022

➤ **Training** / code camp to be organized (spring 2023 ?)
  - Discharge simulator
  - MHD chain
  - EP workflow ?
  - ETS ?

WPSA.CM Modelling deliverables 2022 (1)

Deliverable ID	Deliverable title	Deliverable Owner	Resources Beneficiary
SA-SE.CM.M.01-T003-D001	MHD stability chain deployed to users	Coelho (IST)	IST
SA-SE.CM.M.01-T004-D001	Application of CarMa-D model in state-space representation for developing RWM control time simulation and test controller concepts	Pigatto (ENEA-RFX)	ENEA
SA-SE.CM.M.01-T005-D001	Report/publication on the modelling of multiple pellet injection in self-consistently evolving pedestal profile	Futatani (CIEMAT)	CIEMAT
SA-SE.CM.M.02-T003-D001	Report/publication on integrated modelling of ramp up of initial phase Scenario 2 with first principles transport models	Garzotti (CCFE)	UKAEA
SA-SE.CM.M.02-T003-D002	Report/publication on integrated modelling of ramp up of initial phase Scenario 2 with first principles transport models	Strand (VR)	VR CEA
SA-SE.CM.M.02-T004-D001	Assessment of the JT-60SA PCI diagnostics measurement, on relevant high-beta turbulence including fast ions.	A Iantchenko (EPFL)	EPFL
SA-SE.CM.M.03-T003-D001	Final report on the modelling of initial research phase II scenarios with edge/SOL transport code	G Falchetto (CEA)	CEA
SA-SE.CM.M.03-T003-D002	Assessment of JT-60SA Initial research phase II scenario 2 via edge modelling integrated with core conditions.	L Balbinot (ENEA RFX)	ENEA
SA-SE.CM.M.03-T003-D003	Final report on the modelling of C wall Scenario 2 with SOLPS-ITER.	Piotr Chmielewski (IPPLM)	IPPLM
SA-SE.CM.M.03-T004-D001	Report/publication on the benchmark of SOLPS_ITER to SONIC.	G Rubino (ENEA, Tuscia)	ENEA
SA-SE.CM.M.04-T002-D001	Demonstration of automated application of the EP workflow to the assessment of EP-stability in ramp-up and steady state plasmas.	Ph Lauber (IPP-Garching)	MPG
SA-SE.CM.M.04-T002-D002	Report/publication on linear AE stability of JT-60SA initial research phase H and D scenarios	R Coelho (IST)	IST
SA-SE.CM.M.04-T002-D003	Provide ASCOT distribution function for beam ions	Antti Snicker(VTT)	VTT
SA-SE.CM.M.05-T003-D001	Preliminary report on the validation of disruption modelling tools (CarMa0NL-CARIDDI) on first JT-60SA mechanical data	Villone (CREATE)	ENEA
SA-SE.CM.M.05-T004-D001	Estimate of heat load levels and distributions caused by REs at JT-60SA via a workflow coupling particle tracing codes to FLUKA.	J Caloud (IPP.CR)	IPP.CR

WPSA.CM Operation and synthetic diagnostics 2022 (2)

Deliverable ID	Deliverable title	Deliverable Owner	Resources Beneficiary
SA-SE.CM.OP.01-T002-D001	Verified JT-60SA pulse simulator including implementation of current, gaps and vertical stabilization controllers	Joffrin (CEA)	CEA
SA-SE.CM.OP.01-T003-D001	Provision of discharge simulator select test cases	William Bin	ENEA
SA-SE.CM.OP.02-T001-D001	Report on the validation of TOMATOR-1D code on the first data from JT-60SA Integrated Commissioning	Johan Buermans	LPP-ERM-KMS
SA-SE.CM.OP.03-T002-D001	Documentation on runs on JT60-SA breakdown using a nonlinear optimization technique.	Daria Ricci (ENEA-CNR)	ENEA
SA-SE.CM.OP.04-T002-D001	Plan for the implementation of IDAV for JT-60SA scientific exploitation	Rainer Fischer (IPP-Garching)	MPG
SA-SE.CM.OP.05-T002-D001	Proposal for building parsimonious disruption mitigation/avoidance triggers_CIEMAT	Jesus Vega (CIEMAT)	CIEMAT
SA-SE.CM.OP.05-T002-D002	Proposal for building parsimonious disruption mitigation/avoidance trigger_ENEA_IAP	M Gelfusa	ENEA IAP
SA-SE.CM.OP.05-T002-D003	Proposal for building parsimonious disruption mitigation/avoidance triggers_NCSRD	Fotis Bairaktaris	NCSRD
SA-SE.CM.SD.01-T003-D001	Feasibility study of tomographic inversion for characterizing runaways in plasma conditions relevant for JT-60SA	Cavalier (IPP.CR)	IPP.CR
SA-SE.CM.SD.01-T004-D001	Improved EDICAM visualization tools	Szepesi (EK)	EK-CER
SA-SE.CM.SD.02-T001-D001	Optimization of FILD detector head geometry using synthetic diagnostics	Manuel Garcia-Munoz	CIEMAT