

Physics Project Board #5

Plasma Science for ITER, DEMO and stellarators department overview

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30th of October 2024



This work has been carried out within the framework of the EUROfusion Consortium, funded by the European Union via the Euratom Research and Training Programme (Grant Agreement No 101052200 — EUROfusion). Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.





Objectives for 2025

- Address physics gaps for ITER with the priority on the contemporary ITER scientific needs
- Support the DEMO physics programme
- Identification of physics gaps towards a stellarator-based reactor
- Increase focus on interpretative modelling by securing financial support for these activities
- Build towards a stronger focus on uncertainty qualification to provide a more robust extrapolation for ITER and DEMO

Organized in 4 Work Packages:

Tokamak Exploitation (WP TE), Plasma Wall Interaction & Exhaust (WP PWIE), W7-X Exploitation (WP W7-X) and JT-60SA Enhancements & Commissioning (WP SA)

WP PrIO transferred from former FSD to ITD but agreed, as stated in CWP, to retain in PB of Physics Departments for 2024



- A need to define a transparent framework for projects accorss EUROfusion programme for ITER & to better channel the objectives of the programme towards ITER needs
 - Embarking together with Technology Department to define a [MOU between ITER and EUROfusion for Collaboration in Fusion R&D](#) for mutual benefit and reciprocity
 - Initiating [documentation of activities across all WPs towards ITER](#) starting with ITER modelling; to extend in 2025 towards experimental activities & their relationship with ITER re-baselined Research Plan
- WP PWIE & WP TE reacted to ITER re-baseline by adapting scientific objectives to new needs, experimental time, interpretive & predictive modelling activities → [PSD proposing increased exploitation and mission resources across WP TE and WP PWIE for 2025 \(secured increased resources inside WP PWIE for successful demonstration of LIBS at JET in Oct 2024\)](#)
- Together with F4E increased activity to promote early transition to W wall on JT-60SA (pursue original idea as an ITER satellite)



DEMO

- Increase integration between engineering & physics departments on DEMO related activities, as DEMO is an essential objective for EUROfusion
- In September 2020, a document was drafted in DCT specifying DEMO physics gaps with high, medium and low priority → document had major impact on final JET 2022/23 experimental programme (e.g. QCE, X-point radiator, magnetic flux pumping) & continues to guide experiments on ASDEX Upgrade, MAST-U, TCV and WEST
- In 2024 together with DCT we reviewed the physics gaps document to identify areas requiring further attention & discussion following the activities from 2021 and to mid 2024 → action book drafted as an internal guideline for DEMO related activities to be addressed in 2025 and beyond
- With recommendations for further activities regarding VNS pending next GA PSD department is proposing to reserve some funds to potentially address physics questions in 2025



Stellarator

- Aim to enhance the European participation to W7-X Exploitation for 2025
- Identified a need to evaluate & define the critical physics uncertainties associated with a Stellarator DEMO, identify corresponding research requirements, and determine which of these can be addressed within the scope of Work Package W7-X:
 - Establish high-level objectives by June 2025, followed by an in-depth analysis to be concluded by the end of 2025 → provide a document of Stellarator DEMO/HELIAAS physics gaps
 - This would then additionally allow the concept of Subjective Scientific Readiness Levels applied to WP TE to be extended to Stellarators
- PSD is proposing increase of participation resources for scientific exploitation and allocation of resources to define physics gaps for 2025



Enhancements in WP TE approved by GA in July 2024

Monitoring and earlier identification of (financial) risks

PSD to survey every 4 months the status of the TE enhancement projects with the aim to follow the overall progress, monitor risks resources availability & occurred costs with impact on deliverables

WEST

- High Definition Visible Endoscope
- Retarding Field Analyzer for Io Temperature Measurement in the SOL
- IRBO - IR Bolometry
- Boronization Probes for WEST
- LIBS4FUSION: in-vessel fuel Inventory and deposited layers composition in a full tungsten device
- Fast Ion Loss Detector
- QCM for boronisation and material migration studies in a full W environment (Cancellation requested. Under review)

ASDEX-U

- FIRE&GO - Fast Ion Research Enhancements and Gamma-ray Observations
- Real-time spectroscopy at ASDEX Upgrade
- Ultra-fast-swept profile reflectometer on AUG
- Direct Digital Synthesis for the O-mode Profile Reflectometer at ASDEX Upgrade
- Real-time control system for ELM buffering at ASDEX Upgrade

TCV

- New 100-Hz Laser for the TCV Thomson Scattering System
- Collective Thomson Scattering (CTS) diagnostic
- Runaway Electron Mitigation Coil
- Implementation of the 4th dual-frequency gyrotron
- Upgrade of the TCV LHPI antenna
- Upgrade of the TCV ECRH high voltage power supply
- Runaway electron mitigation and velocity analysis by magnetic-ripple manipulation (PMP not yet provided)
- Development of a Co-spatial Ion and Electron Spectroscopy (CIES) diagnostic (Cancelled)

MAST-U

- ONCOMING - Optimized tangentially spaced resolved geM Imaging
- Neutron Detectors suite for 14 MeV neutron triton burnup and 2.5 MeV neutron spectroscopy measurements

COMPASS-U

- Tungsten impurity monitoring and control
- Characterisation of advanced confinement modes
- PFCs and diagnostics for power exhaust studies



Ensure alignment of scientific exploitation of JT-60SA with priorities & objectives of EUROfusion programme

- Re-prioritize scientific objectives for C phase assuming only inertially cooled C wall
- Define scientific priorities for W wall
- Define possible scenarios in W wall & their impact on additional requirements e.g. ECRH heating, diagnostics, W divertor & W first wall on JT-60SA, ...
- WP SA leader C. Sozzi to provide overall coordination platform across various WP involved (WP DIV, WP PWIE, WP SA, WP TE)
- Initiated discussions at various levels with F4E, QST, ITER:
 - [Promote early transition to W](#) → aim is to secure start of JT-60SA operation with W wall > 1 year before ITER operation
 - Provide a [structure to participate to device operation](#), promote information exchange between scientific teams and machine operation, establish procedures/platforms for data validation → part of transition from initial integrated commissioning to scientific exploitation expected to start late 2026



Produce 1st draft of a Research Plan for BEST by the end of 2025 together with Chinese counterparts with the aim to identify if & to which extent EUROfusion could/should embark on a joint scientific exploitation of BEST following the recommendations by the Facility review panel

- PSD is proposing to allocate funds to support activities of topical coordinators & urgent modelling needs with unique expertise in Europe that could not be undertaken timely by Chinese counterparts
- 4th/5th of November European kick-off meeting in Garching & 26th – 29th of November Joint kick-off meeting in Hefei

Name	Beneficiary	Topic
Yevgen Kazakov	LPP-ERM-KMS	Overall coordination of the research plan and the strategy for the exploitation of BEST
Emmanuel JOFFRIN	CEA	Plasma scenarios
Julien HILLAIRET	CEA	Physics of heating, current drive and fuelling
Jonathan Graves	EPFL	MHD, disruptions and control
Rui Coelho	IST	Energetic particle physics
Paola Mantica	ENEA	Transport physics and integrated modelling
Ou Pan	MPG	Divertor, SOL physics and plasma-wall interactions
Matteo Valerio Falessi	ENEA	Theory and simulation
Rosaria Villari	ENEA	Fusion technology developments
Richard Kamendje	PMU – contact point with Fusion technology departments in EUROfusion	Fusion technology developments



Proposing a new Work Package for scientific support to Future Devices

- Presently resources for planned “Helias” physics gaps, planned BEST activities, possible VNS & DTT activities are distributed across various WPs whose objectives are either not in line with WP activities or where an enriching dialogue might not be guaranteed
- ➔ Proposal: Project Board is asked to recommend the creation of a WP for scientific support of future devices without a WP leader, managed and administered directly by the PSD department, with scientific objectives to be defined (e.g. BEST Research Plan, Stellarator DEMO physics gaps document, ...);



PSD proposals

- Proposed redistribution of resources across all WP inside PSD + WP PrIO will secure the objectives of PSD in 2025
 - to reduce risk of unused resources by end of 2025
 - proposed redistribution has been discussed and agreed with all WP Leaders and HoD of ITD (for WP PrIO)
- PSD proposes to create a new WP with reserve limited resources for potential presently unspecified new activities towards VNS and/or DTT in 2025 pending decisions on these activities at upcoming GA in Dec. 2024
- PSD is implementing measures to reduce the number of level 3 reports and to motivate concise reporting
- Aiming to apply SSRs to PWIE (as its objectives are mostly ITER/DEMO as for TE)