

Annex 2: Task description within SP-3. EUROfusion support to the ECRH System

Commissioning for ITER

The Electron Cyclotron Resonance Heating (ECRH) system is one of the key heating and current drive systems for ITER that must be commissioned and available for first plasma operation and scientific exploitation. In the context of the revision of the ITER research plan, it is proposed to provide 40 MW of ECRH to reach H-mode performance in D-D plasmas with a tungsten wall during the first scientific exploitation phase, and to further increase to about 67 MW during the first D-T operation, where the power will be delivered by more than 70 to 80 gyrotrons. To reach this ambitious goal, the elaboration and demonstration of well-established commissioning procedures and interlocks for the ECRH system to deliver reliable continuous (CW) power in a metallic first wall environment are required.

As part of the EUROfusion Operations Network (EON) activity, chaired by E. Belonohy, an ECRH network was set up in 2023 as a joint collaboration between Fusion for Energy (F4E) and EUROfusion. The network includes EUROfusion and F4E teams in Europe involved in ECRH design, operation, and exploitation, including the JT-60SA team (under the Broader Approach Agreement). The objectives are to (i) facilitate stronger connections between the operational groups of European ECRH facilities to share operational experience, (ii) support the development and training of operators, and (iii) contribute to EUROfusion's preparation for the (integrated) commissioning and operation of the ITER ECRH system. Additionally, the "Heating and Current Drive" Work Package (WP-HCD) focuses on the design and R&D of the ECRH and Current Drive for DEMO (design and integration, critical R&D development).

In this challenging context, it is clear that the demand for ECRH experts and expertise for existing EU facilities or those under construction, for ITER and DEMO, will grow significantly. However, the EU is already facing a shortage of experts, as some are retiring or leaving the field.

This call should be viewed as an opportunity and a contribution to partially fill these identified gaps (training ECRH experts, developing and testing operation and commissioning procedures for ECRH systems for ITER application) through a joint collaborative effort on the commissioning of the CW ECRH system in support of ITER in collaboration with the ITER Organisation, F4E, EUROfusion labs, and, when relevant, in partnership with industry. These opportunities are timely for EUROfusion, particularly in the context of ITER's recent evolution and the revision of the ITER research plan. Indeed, EUROfusion labs have developed significant expertise in this field by designing, commissioning, and operating high-power and continuous ECRH systems.

The call aims to expand the 2024 activity following the creation of the joint EUROfusion-F4E ECRH network (voluntary contribution in 2024) with “hands-on” activities on ECRH commissioning and operation for future ITER applications and knowledge transmission. In addition to the resources to cover the professional months, resources could include short-term missions to relevant EUROfusion facilities or/and at the ITER site (in agreement with IO), participation in the operation of the ECRH plant, and, procurement (pending resources) within EUROfusion rules of relevant hardware properly justified and aligned with the identified deliverables.

The proposal should elaborate on at least one of the following items related to the commissioning of the ECRH system in support of ITER:

1. Train users and operators of gyrotrons within an integrated ECRH system to become familiar with commissioning procedures in advance of ITER;
2. Develop, test, and validate ECRH plant commissioning procedures in advance of the ITER ECRH system;
3. Commission and validate test stands with CW high-power gyrotrons;
4. Commission and validate CW gyrotrons and long pulse operation of critical components for the ITER ECRH systems (MOU, RF load, transmission line components, magnets);
5. Commission the integrated ECRH transmitter before starting plasma operation.

The key deliverable to be reached by 2025 is to provide a validated (on existing facility) commissioning procedure of the CW ECRH system or one of its major parts that is directly transferable to ITER applications and the ECRH plant. Due to limited resources, the selection will be based on the relevance to ITER's first scientific exploitation, the synergy with the existing EUROfusion programme, and compliance with the key deliverable.