Annex "Open EUROfusion Challenges to inspire EBBRG Proposals" (AWP23)

Introduction

EBBRG topics can be submitted on various research lines. The evaluation criteria are: Excellence of Research Project, Competence Development, Candidate Background. Also, candidates are asked to motivate how their proposal aligns with EUROfusion's work (see Annex 2 – Guide for Applicants). This Annex aims to provide a brief overview.

Below some suggestions structured per Mission. They are ***not*** *prescriptive, as the aim is to challenge proponents to come up with creative ideas to tackle outstanding problems on the Road to Fusion. These are formulated for a wide audience in the European Research Roadmap to the Realisation of Fusion Energy.*

Mission 1 – Plasma Regimes of Operation: Demonstrate plasma scenarios (based on the tokamak configuration) that increase the success margin of ITER and satisfy the requirements of DEMO. High-level objectives are to demonstrate and qualify MHD-stable high-performance operation with metallic plasma facing components for ITER and DEMO; to enhance the physics understanding in order to control the operation of burning plasmas in ITER and DEMO; to develop integrated scenarios with controllers for long pulse, ultimately steady-state, operation for ITER and DEMO.

Mission 2 – Heat Exhaust Systems: Demonstrate an integrated approach that can handle the large power leaving ITER and DEMO plasmas. High-level objectives: Detachment control for ITER, DEMO baseline and HELIAS (the helical-axis advanced stellarator line) operation. Prepare efficient Plasma Facing Components (PFC) operation for ITER, DEMO and HELIAS. Investigate alternative innovative divertor geometries for DEMO. Develop a liquid-metal based divertor solution for DEMO.

Mission 3 – Develop Neutron resilient materials: Develop materials that withstand the large 14MeV neutron flux for long periods while retaining adequate physical properties. High-level objectives: Support finalisation of the IFMIF-DONES design and construction; Implementation of a neutron irradiation programme in suitable material test reactors for DEMO relevant conditions incl. post-irradiation experiments; Implementation of the data in the Material Property Handbook and development of DEMO specific design rules for radiation loaded components; Materials modelling and experimental validation; Development and characterisation of advanced materials towards industrial manufacturing, qualification of joining technologies.

Mission 4 – Ensure tritium self-sufficiency: Find an effective technological solution for the breeding blanket which also drives the generators. High-level objectives: Advance the technology maturity of the most attractive blanket concepts (i.e., WCLL, HCPB) for ITER TBM and DEMO; Validate (design and R&D) of the fuel cycle architecture and its underlying elements; Validate the tritium containment control strategy; Understand the future availability of tritium and evaluate the impact of limited resources on the timeline of DEMO and develop mitigations.

Mission 5 – Implementation of the intrinsic safety features of fusion: Ensure safety is integral to the design of DEMO using the experience gained with ITER. High-level objectives: Definition of DEMO safety approach to licensing regulatory requirements; Integration of safety analyses and demonstration of safety margins in the design; Development and maintenance of processes and tools that enable DEMO safety assessments; Preliminary Safety Report for the DEMO Conceptual Design (including Decommissioning Plan).

Mission 6 – Conceptual DEMO design: Bring together the plasma and all the systems coherently, resolving issues by targeted R&D activities. High-level objectives: Develop the necessary scientific basis (physics and technology) for a feasible and sound conceptual plant design; Bring critical technologies for DEMO to adequate maturity; Establish a structured and traceable conceptual baseline design that provides an integrated solution, meeting the Stakeholders requirements with sufficient margin.

Mission 7 – Competitive cost of electricity: Ensure the economic potential of fusion by minimising the DEMO capital and lifetime costs and developing long-term technologies to further reduce power plant costs. High-level objectives: Development and maturation of potential technologies for fusion which may improve performance and electrical efficiency; Development of novel materials and manufacturing techniques to support the requirements of fusion technology on a large scale; Identification of additional research requirements needed to support the above concepts; Improvement of fusion plant conceptual development tools (including for stellarators); Investigation of market opportunities and challenges for fusion.

Mission 8 – Stellarators: Bring the stellarator line to maturity to determine the feasibility of a stellarator power plant. High-level objectives: Qualification of HELIAS optimised stellarator operation and reactor-like operation based on W7-X results and outcome. Theory development and validation for the prediction of stellarator optimisation. Advancement of specific stellarator engineering and technology in preparation of a next-step device.