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Innovative H&CD designs and the impact of their configurations on the performance of the EU DEMO fusion power plant reactor

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Improvements of Heating & Current Drive (H&CD) systems are being investigated for a demonstration fusion power plant DEMO to deliver net electricity for the grid around 2050 [1]. Compared to ITER, which has to show the generation of 500 MW thermal power, the target of DEMO is the successful production of 300 to 500 MW electrical power to the grid and to aim for a self-sufficient Tritium fuel cycle [2]. Three H&CD systems are under development for DEMO in Europe, the Electron Cyclotron (EC) System, the Neutral Beam Injection (NBI) System and the Ion Cyclotron (IC) System.
Based on present studies [3] for plasma ramp-up, ramp-down and flat top phases, to be further validated in more detailed simulations, the assumed total launched power needed from the H&CD system in DEMO is in the range of 50-100 MW, to be provided for plasma heating and control.
Among other topics, the paper describes the new designs and R&D status of H&CD systems considered for their deployment in DEMO in Europe and the impact of the H&CD configurations on their performances based on those areas described in the European fusion electricity roadmap [4] for the integrated design and system development. These configurations encompass the operation of NBI with reduced Caesium consumption, with modular ion sources and improved injector wall-plug efficiencies, EC system with increased gyrotron frequencies above ITER ones, as well as multi-purpose and frequency step-tunable radio frequency sources, and related strategies for the fabrication of large Brewster angle diamond windows, together with EC launcher designs compatible with a fusion power plant environment, avoiding front-steering by using different launcher concepts.
The project also elaborates on new solutions to further increase the wall-plug efficiencies of H&CD systems based on more advanced concepts, with the target to reduce the recirculating power fraction in future fusion power plants. Different studies under investigation will be discussed such as, for NBI, the photo-neutralization and, for EC, new concepts for gyrotron multi-stage depressed collector.

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[2] Wenninger, R., et al., 'The physics and technology basis entering European system code studies for DEMO' , Nucl. Fusion 57, 016011, 2017
[3] Vincenzi, P., et al, ´EU DEMO transient phases: main constraints and heating mix studies for ramp-up and ramp-down', SOFT 2016, accepted for publication in Fus. Eng. Design
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Eligible for student paper award?

No

Author: Mr FRANKE, Thomas (EUROfusion Consortium)

Co-authors: Mr SIMONIN, Alain (CEA-IRFM); Mr BACHMANN, Christian (EUROfusion Consortium); Mr STRAUSS, Dirk (IAM-AWP, Karlsruhe Institute of Technology (KIT)); Mr AIELLO, Gaetano (IAM-AWP, Karlsruhe Institute of Technology (KIT)); Mr FEDERICI, Gianfranco (EUROfusion Consortium); Mr GROSSETTI, Giovanni (IAM-AWP, Karlsruhe Institute of Technology (KIT)); Mr GRANUCCI, Gustavo (Institute of Plasma Physics "P. Caldirola"); Mr NOTERDAEME, Jean-Marie (Max-Planck-Institut für Plasmaphysik); Mr JELONNEK, John (IHM, Karlsruhe Institute of Technology (KIT)); Mr AVRAMIDIS, Kostas (IHM, Karlsruhe Institute of Technology (KIT)); Mr TRAN, Minh Quang (Swiss Plasma Center (SPC)); Mr SONATO, Piergiorgio (3Consorzio RFX (CNR, ENEA, INFN, Università di Padova, Acciaierie Venete SpA)); Mr AGOSTINETTI, Piero (Consorzio RFX (CNR, ENEA, INFN, Università di Padova, Acciaierie Venete SpA)); Mr VINCENZI, Pietro (Consorzio RFX (CNR, ENEA, INFN, Università di Padova, Acciaierie Venete SpA)); Mr WENNINGER, Ronald (EUROfusion Consortium); Ms ZHENG, Shanliang (Culham Centre for Fusion Energy, Culham Science Centre); Mr SCHERER, Theo (IAM-AWP, Karlsruhe Institute of Technology (KIT))

Presenter: Mr FRANKE, Thomas (EUROfusion Consortium)

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