

Liquid Metal Conceptual Divertor Designs for the European DEMO

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The crucial stepping stone between ITER and a fusion power plant is generally foreseen as a demonstration power plant (DEMO). The European approach foresees only a modest upscaling in dimensions from ITER but due to the large increase in fusion power and subsequently strongly increased power crossing the separatrix [1] this implies increased challenges for power exhaust. As a risk mitigation strategy alternative approaches to this issue are being pursued, including whether a liquid-metal (LM) based divertor could be an option for DEMO.

Such a divertor should be able to handle similar or greater heat fluxes to the baseline approach (an ITER-like W-monoblock based divertor [1]) but is attractive as it could show greater resilience against off-normal events and neutron loading leading to a more robust divertor. A set of design requirements to achieve this goal while conforming to the operational safety and fusion output requirements of DEMO have therefore been formulated in consultation with the European design team. Based on these requirements a series of conceptual designs have been developed within the EUROfusion workpackage WPD TT1-LMD. While several different approaches have been considered the leading candidates are water-cooled designs using tin as the liquid metal. FEM analysis shows that power handling capabilities well above 10 MW m⁻² in steady state are achievable while conforming to design requirements. In addition slow transients, ELMs and disruptions appear tolerable without damage to the PFC. Tin confinement by mesh-based Capillary Porous Structure (CPS) is used, but novel approaches to its production, such as 3D printing, have been investigated. Modelling using TECXY and COREDIV shows that core concentrations of Sn can be limited to tolerable values by Ne or Ar impurity addition. Considerations such as wetting, corrosion and fuel retention are also being addressed. This contribution will discuss the design requirements, experimental inputs and modelling of the design and place it in the context of the European pre-conceptual design efforts for an LM-based divertor for DEMO.

[1] Federici, G. et al. *Fus. Eng. Des.* **109–111** (2016) 1464-1474.

Affiliation

Dutch Institute for Fundamental Energy Research, Plasma Material Interactions, Eindhoven

Country or International Organization

Netherlands

Author: MORGAN, Thomas (Dutch Institute for Fundamental Energy Research)

Co-authors: RINDT, P. (Eindhoven University of Technology, Science and Technology of Nuclear Fusion); CARDOZO, N.J. (Eindhoven University of Technology, Science and Technology of Nuclear Fusion, Eindhoven, The Netherlands); Mr DE LUCA, Riccardo (ENEA, Department of Fusion and Technology for Nuclear Safety and Security, Frascati); Dr DOSE, Giacomo (ENEA, Department of Fusion and Technology for Nuclear Safety and Security, Frascati); IAFRATI, M. (ENEA, Department of Fusion and Technology for Nuclear Safety and Security, Frascati); MANCINI, Anselmo (ENEA, Department of Fusion and Technology for Nuclear Safety and Security, Frascati); MAZZITELLI, Giuseppe (ENEA); Dr ROCCELLA, Selanna (ENEA, Department of Fusion and Technology for Nuclear Safety and Security, Frascati); BARRETT, Thomas (Culham Centre for Fusion Energy (CCFE)); DOMP-TAIL, F. (CCFE, Culham Science Centre, Abingdon); Dr FURSDON, Mike (CCFE); HORSLEY, D. (CCFE, Culham Science Centre, Abingdon, UK); ALEGRE, D. (Fusion National Laboratory, CIEMAT, Madrid, Spain); OYARZ-ABAL, E. (Fusion National Laboratory, CIEMAT, Madrid, Spain); TABARES, Francisco (Ciemat); PERICOLI RIDOLFINI, Vincenzo (PoIPP); CHMIELEWSKI, P. (Institute of Plasma Physics and Laser Microfusion, Warsaw, Poland); IVANOVA-STANIK, Irena (Institute of Plasma Physics and Laser Microfusion); PORADZIŃSKI, M. (Institute of Plasma Physics and Laser Microfusion, Warsaw, Poland); ZAGORSKI, Roman (Institute of Plasma Physics

and Laser Microfusion); Dr AMBROSINO, Roberto (Consorzio CREATE); CRISANTI, Flavio (ENEA); Dr GHIDERSA, B-E (KIT)

Presenter: MORGAN, Thomas (Dutch Institute for Fundamental Energy Research)

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