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Power Handling and Plasma Protection Aspects that affect the Design of the DEMO Divertor and First Wall

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The development of a conceptual design for a demonstration fusion power plant (DEMO) is a key priority of the recent European fusion program [1]. The DEMO design/R&D is expected to benefit largely from the experience gained with ITER construction and operation, but there are still outstanding gaps requiring a vigorous physics and technology R&D programme. The constraints coming from specific DEMO requirements bear a strong impact in the design and technology selection process of the components surrounding the plasma. This paper discusses some of the main risks related to the divertor and first wall configuration and the related benefits / shortcomings of alternative design options.
The recent pulsed "low extrapolation"DEMO baseline design includes a lower single null (LSN) configuration, a conventional x-point divertor (closed) and no high heatflux components outside the divertor. A number of weaknesses of this design are discussed:
• First wall protection: A low total heat load limit of ˜1 MW/m2 for the first wall in DEMO and an increased SOL e-folding length for the steady state charged particle transport due to enhanced level of blob transport are expected for DEMO.
• Divertor protection: DEMO aspects like the high radiation requirement, high neutron exposure and the more challenging ELM problem lead to high divertor protection challenges than in ITER.
• Vertical stability: In addition to the large distance between plasma and conducting wall in DEMO, LSN suffer from a strong coupling between horizontal and vertical displacements.

Due to these issues of the DEMO baseline design, alternative design options are to be investigated:
• Sacrificial limiters with high heat load capabilities in the first wall: For designs with poloidally elongated limiters a heat load analysis, impact on the Tritium Breeding Ratio and several design integration aspects are discussed.
• Double null configuration (DN): The most recent findings on the potential of DN to simultaneously improve the situation at the first wall and divertor and also the vertical stability will be presented. Also drawbacks of DN (e.g. TBR reduction) will be discussed.

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Primary author: Dr WENNINGER, Ronald (Max-Planck-Institut für Plasmaphysik)

Co-authors: Dr SIEGLIN, Bernhard (Max-Planck-Institut für Plasmaphysik, Garching, Germany); Mr BACH-MANN, Christian (EUROfusion Programme Management Unit, Garching, Germany); Dr LOWRY, Christopher (European Commission); Dr COSTER, David (Max-Planck-Institut für Plasmaphysik, Garching, Germany); Dr MAVIGLIA, Francesco (EUROfusion Programme Management Unit, Garching, Germany); Dr FEDERICI, Gianfranco (EUROfusion Programme Management Unit, Garching, Germany); Prof. ZOHM, Hartmut (Max-Planck-Institut für Plasmaphysik); Prof. LACKNER, Karl (Max-Planck-Institut für Plasmaphysik, Garching, Germany); Mr BARBATO, Lucio (Università di Napoli Federico II, Corso Umberto I, 40bis, 80138 Napoli, Italy); Dr SICCINIO, Mattia (Max-Planck-Institut für Plasmaphysik, Garching, Germany); Prof. MATTEI, Maximiliano (DIII, Seconda Università di Napoli, Aversa (CE), Italy); Dr FIRDAOUSS, Mehdi (CEA, IRFM, F-13108 St Paul-Lez-Durance, France); Dr TURNYANSKIY, Mikhail (EURATOM/CCFE Fusion Association); Dr ALBANESE, Raffaele (Università di Napoli Federico II, Corso Umberto I, 40bis, 80138 Napoli, Italy); Dr KEMP, Richard (Culham Centre for Fusion Energy); Dr AMBROSINO, Roberto (Università di Napoli Parthenope, Via Medina, 40, 80133 Napoli, Italy); Prof. NEU, Rudolph (Max-Planck-Institut für Plasmaphysik, Garching, Germany); Dr EICH, Thomas (Max-Planck-Institute for Plasma Physics); Mr BARRETT, Tom (CCFE, Culham Science Centre, Oxfordshire OX14 3DB, United Kingdom); Prof. BIEL, Wolfgang (Forschungszentrum Jülich, 52425 Jülich, Germany)

Presenter: Dr WENNINGER, Ronald (Max-Planck-Institut für Plasmaphysik)

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