# Analysis of the cooling of in-vessel components

## Introduction

Considering the high dose levels which will be reached inside a tokamak fusion power plant, the maintenance of in-vessel components (IVC), such as the Breeding Blanket (BB), must be carried out with Remote Maintenance (RM) technologies. The requirements for the operation of the RM robots are very strict, considering the extreme precision required for the handling of very large objects (e.g. a BB segment is ~10 m high) in very narrow spaces. One of such requirements is the temperature of the handled item, which, for the BB maintenance, must be below 150 °C. With the machine in non-operating state, the BB segments must then be cooled down from their operating temperature (~300 °C) to the RM operating temperature. This could be done either in natural convection or in forced convection regimes; an analysis in natural convection is currently being carried out in the case of the Helium-Cooled Pebble Bed (HCPB) [1] BB concept.

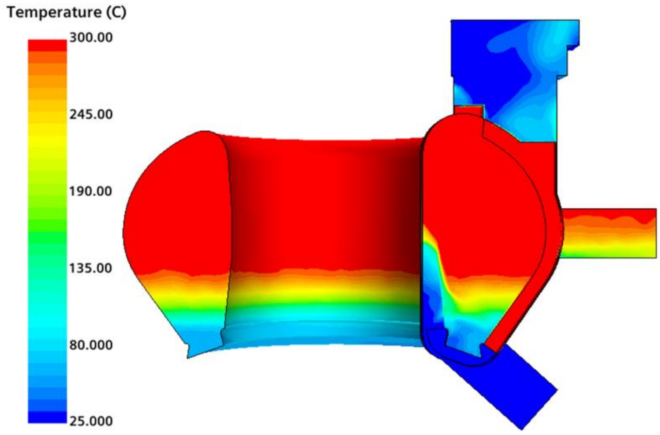


*Figure 1: Temperature map of the air in natural circulation after 1 day from reactor shutdown.*

## Aim of the work

The analysis of the BB cooling for the intervention of RM must be carried out using 3D Computational Fluid-Dynamic (CFD) models to solve the Conjugate Heat Transfer (CHT) problem at hand. The aim of this work is to:

1. build a suitable mesh in the case of forced (and turbulent) flow
2. investigate the models to be adopted in the analysis
3. find the best solution strategy to tackle the multi-time scales nature of the problem.

The work should consider both the HCPB and the Water-Cooled Lithium-Lead [2] BB concepts. After the selection of models and mesh generation strategy, the full 3D transient analysis will be carried out exploiting High-Performance Computing (HPC) facilities.

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## References


[1] F. A. Hernández et al., "Overview of the HCPB Research Activities in EUROfusion," IEEE Transactions on Plasma Science 46(6):2247+2261, 2018.

[2] A. Del Nevo et al., "Recent progress in developing a feasible and integrated conceptual design of the WCLL BB in EUROfusion project," Fusion Engineering and Design 146(B):1805-1809, 2019.