

Preliminary structural assessment of the HELIAS 5-B breeding blanket

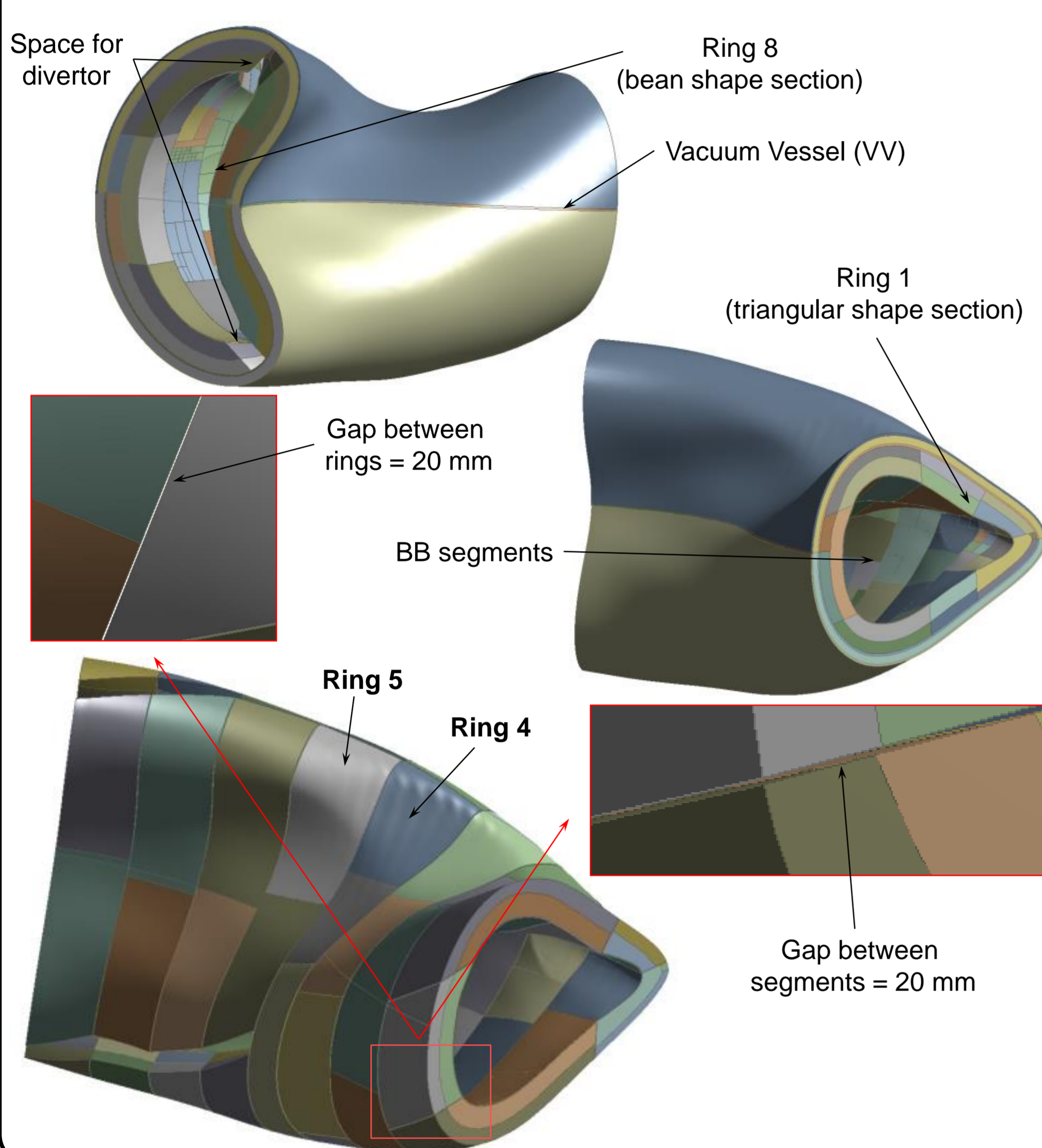
G. Bongiovi¹, A. Häußler¹, P. Arena² and the W7-X team

¹Karlsruhe Institute of Technology, Germany

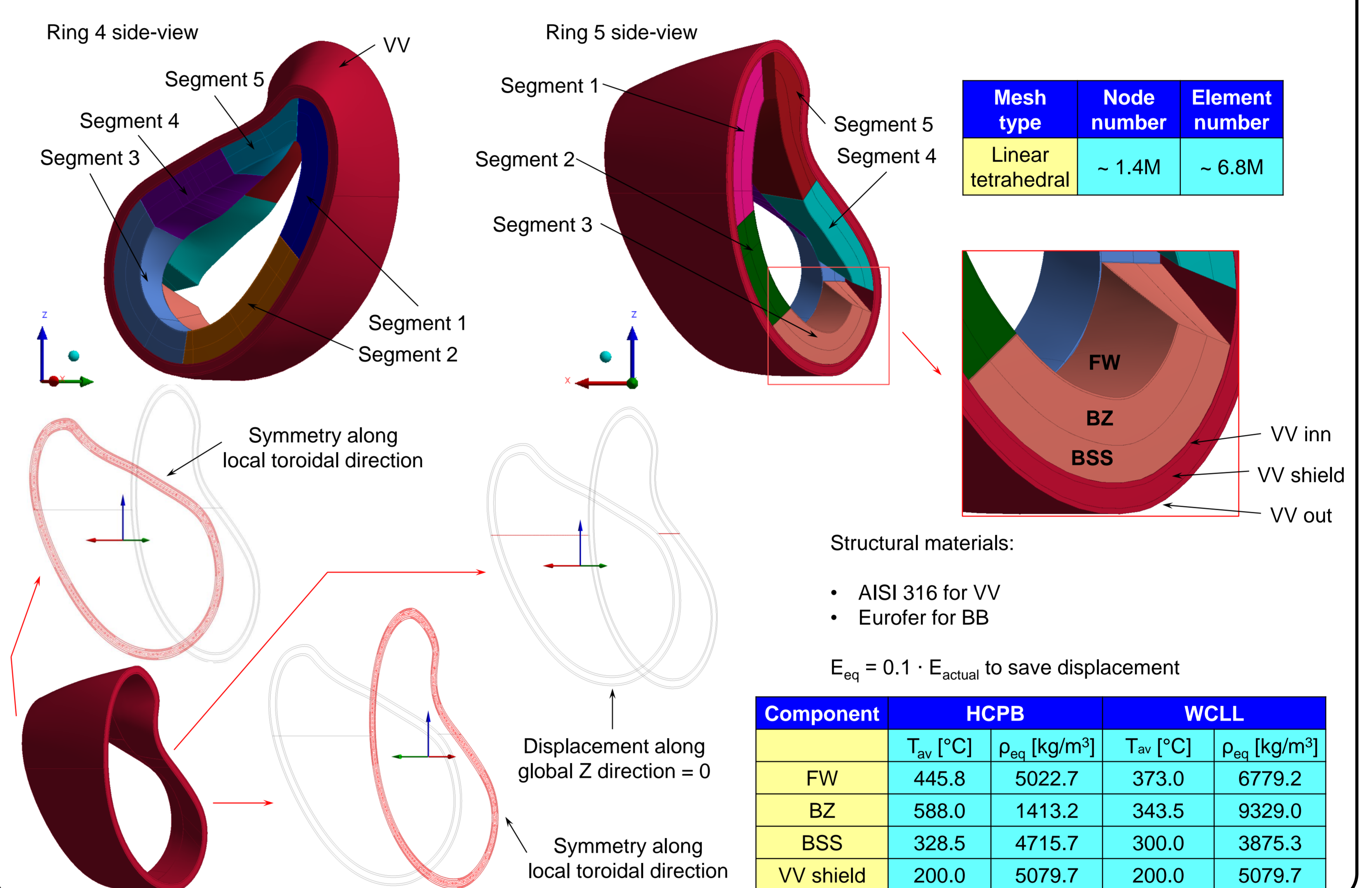
²Università di Palermo, Italy

The European Roadmap to the realisation of fusion energy considers the stellarator concept as a possible long-term alternative to a tokamak fusion power plant. To this purpose a pivotal issue is the design of a HELIAS-axis Advanced Stellarator (HELIAS) machine equipped with a tritium Breeding Blanket (BB). Therefore, within the framework of EUROfusion Work Package S2 R&D activity, a research campaign has been launched at KIT. The scope of the research, focussed on the HELIAS 5-B machine, has been the determination of a preliminary BB segmentation scheme able to ensure, under the assumed loading conditions, that no overlapping may occur among the BB neighbouring regions. To this purpose, the Helium-Cooled Pebble Bed (HCPB) and the Water-Cooled Lithium Lead (WCLL) BB concepts, presently considered for the DEMO tokamak fusion reactor, have been taken into account. The obtained results are herewith presented and critically discussed.

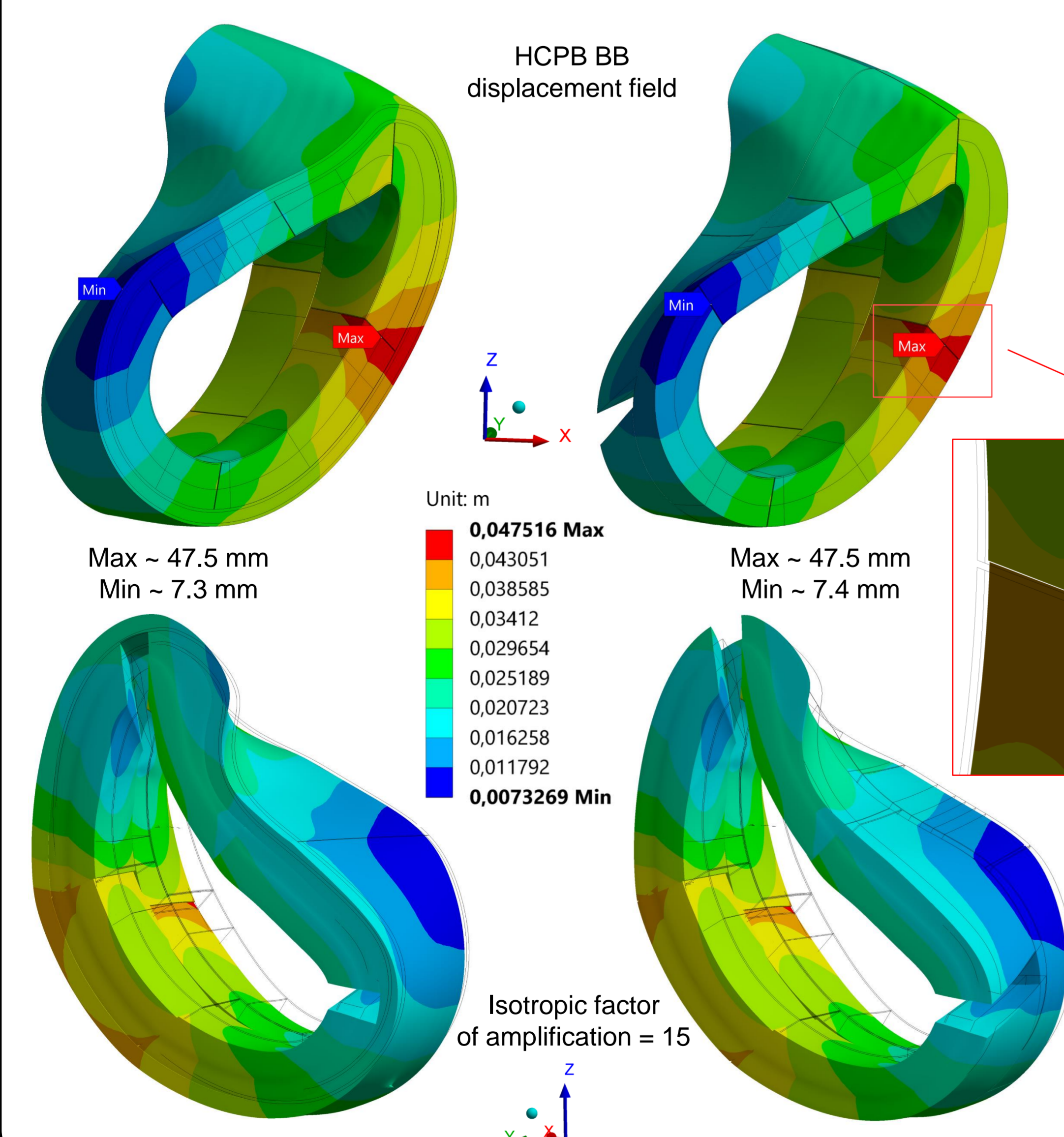
The HELIAS 5-B Breeding Blanket (BB)



The 3D FEM model of the HELIAS 5-B BB central region



Results



Segment interface	HCPB BB concept			
	Max. residual gap [mm]		Min. residual gap [mm]	
	Ring 4	Ring 5	Ring 4	Ring 5
1-2	2.8	4.6	2.1	3.9
2-3	13.6	9.3	13.4	9.0
3-4	9.8	N/A	9.7	N/A
4-5	13.7	21.0	12.5	20.0
5-1	13.9	N/A	7.7	N/A

Segment interface	WCLL BB concept			
	Max. residual gap [mm]		Min. residual gap [mm]	
	Ring 4	Ring 5	Ring 4	Ring 5
1-2	16.2	15.6	15.6	15.3
2-3	22.1	18.7	21.6	18.5
3-4	15.6	N/A	15.6	N/A
4-5	8.6	19.6	8.6	19.5
5-1	17.7	N/A	14.6	N/A

Segment	Max. displacement towards adjacent rings			
	HCPB BB [mm]		WCLL BB [mm]	
	Ring 4	Ring 5	Ring 4	Ring 5
1	8.5	4.9	3.9	1.9
2	4.9	4.4	1.8	1.6
3	3.5	4.4	2.1	1.5
4	5.4	3.2	3.3	0.1
5	3.0	5.3	0.0	2.3

Ring 4-5 toroidal gap		
	HCPB BB	WCLL BB
Min. residual value [mm]	7.8	14.2

Conclusion

Both HCPB and WCLL concepts can be, in principle, taken into account for the HELIAS 5-B BB potential design. As to HCPB, which represents the most critical case, the obtained results allow concluding that, even though BB segments overlapping may be excluded in the HELIAS 5-B BB central region, further analysis is necessary, adopting more realistic models, in order to confirm these preliminary outcomes. Moreover, displacement towards divertor openings represents a strong concern to be considered for the future.