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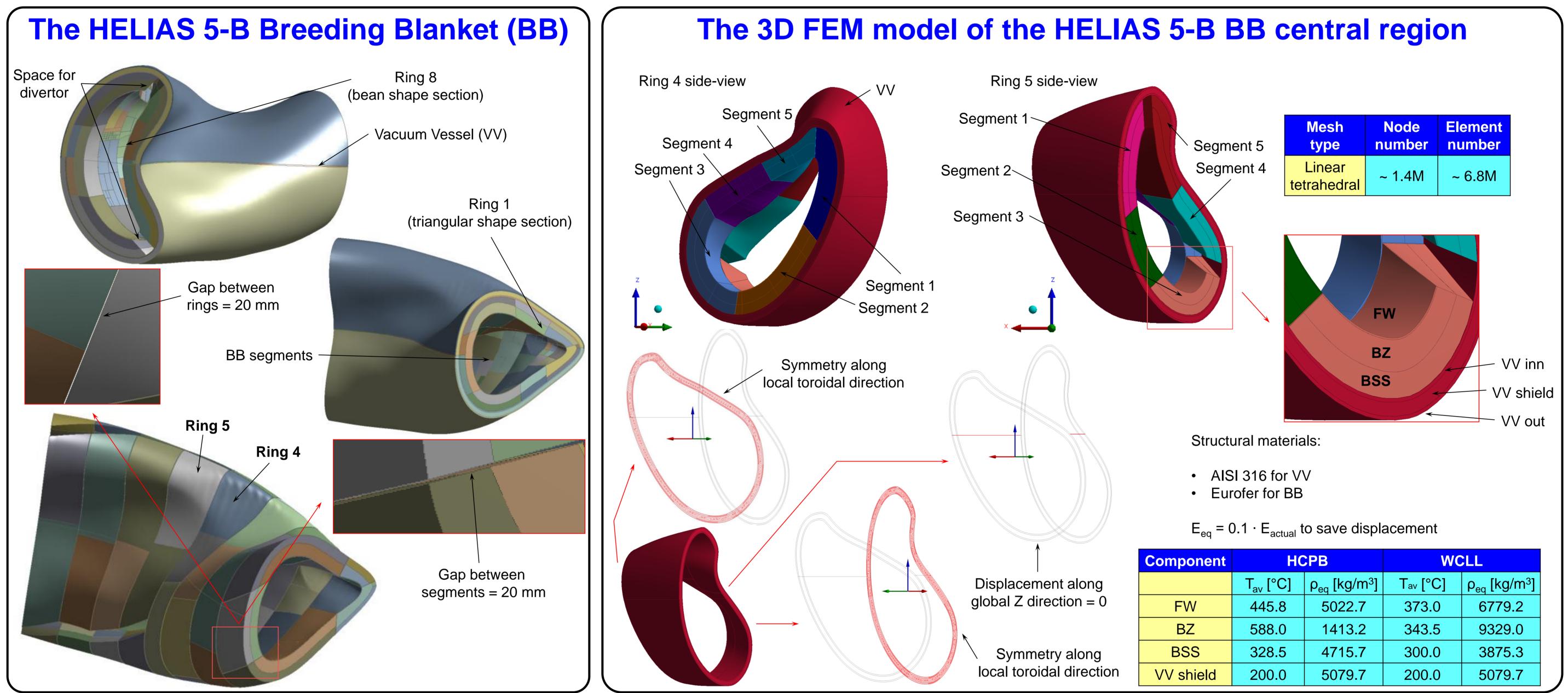
Preliminary structural assessment of the HELIAS 5-B breeding blanket

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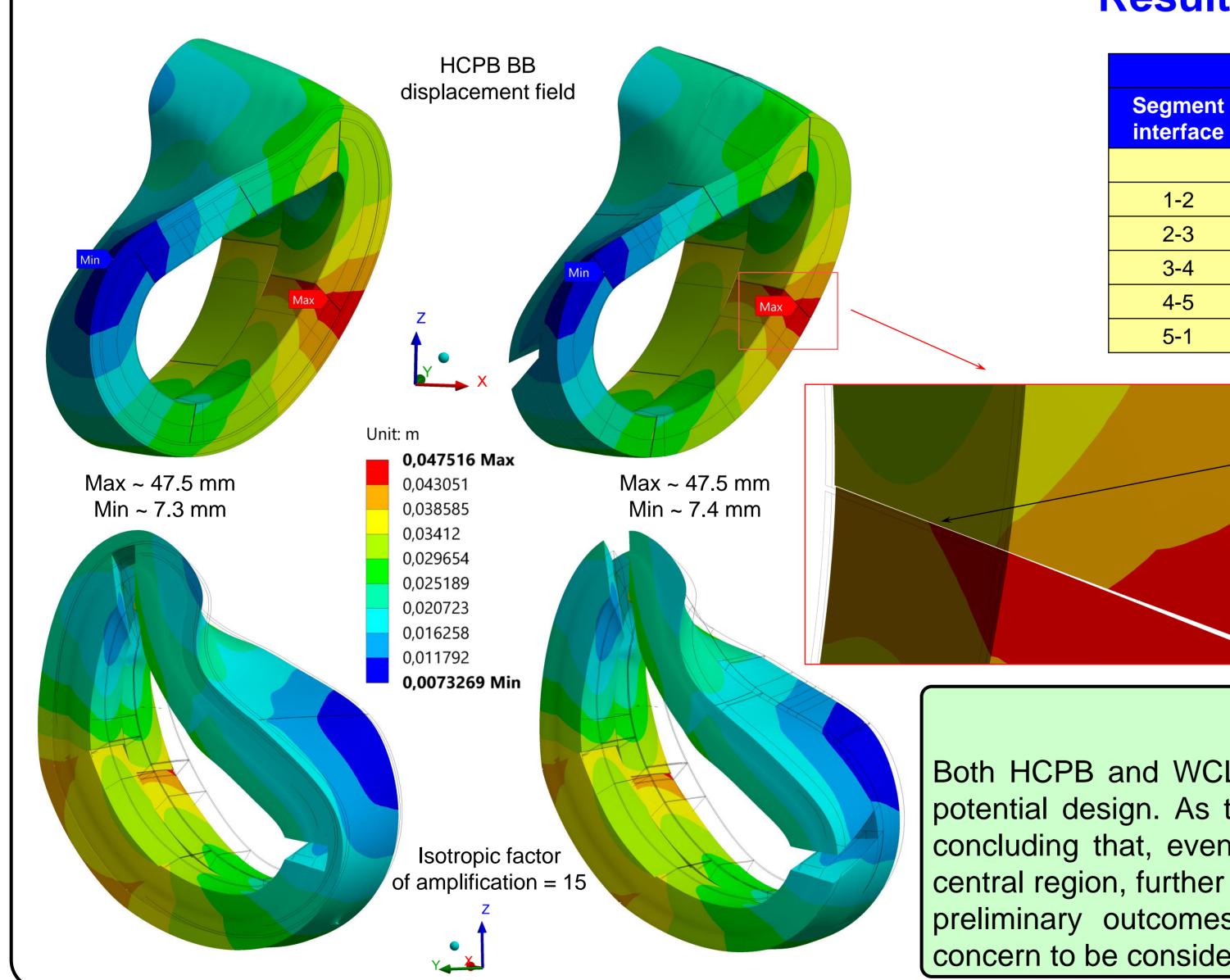
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The European Roadmap to the realisation of fusion energy considers the stellarator concept as a possible long-term alternative to a tokamak fusion power plant. To this purpose a pivotal issue is the design of a HELIcal-axis Advanced Stellarator (HELIAS) 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.



	T _{av} [°C]	ρ _{eq} [kg/m³]	Tav [°C]	ρ _{eq} [kg/m³]
FW	445.8	5022.7	373.0	6779.2
BZ	588.0	1413.2	343.5	9329.0
BSS	328.5	4715.7	300.0	3875.3
VV shield	200.0	5079.7	200.0	5079.7



Results

HCPB BB concept						
Segment interface	Max. residual gap [mm]		Min. residual gap [mm]			
	Ring 4	Ring 5	Ring 4	Ring 5		
1-2	2.8	3 4.6 2.1		3.9		
2-3	13.6	9.3	13.4	9.0		
3-4	9.8	9.8 N/A 9		N/A		
4-5	13.7 21.0 12.5		12.5	20.0		
5-1	13.9	N/A	7.7	N/A		

Min. residual

value [mm]

Min: residual gap = 2.1 mm

(deformed view)

Ring 4-5 toroidal gap

WCLL BB concept						
Segment interface	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		

		Max. displacement towards adjacent rings				
ap = 2.1 mm d view)		Segment	HCPB BB [mm]		WCLL BB [mm]	
			Ring 4	Ring 5	Ring 4	Ring 5
		1	8.5	4.9	3.9	1.9
toroidal gap		2	4.9	4.4	1.8	1.6
	WCLL BB	3	3.5	4.4	2.1	1.5
7.0	44.0	4	5.4	3.2	3.3	0.1
7.8	14.2	5	3.0	5.3	0.0	2.3

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.







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KIT – The Research University in the Helmholtz Association

