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Analysis of EM loads on DEMO WCLL Breeding Blanket during VDE-up

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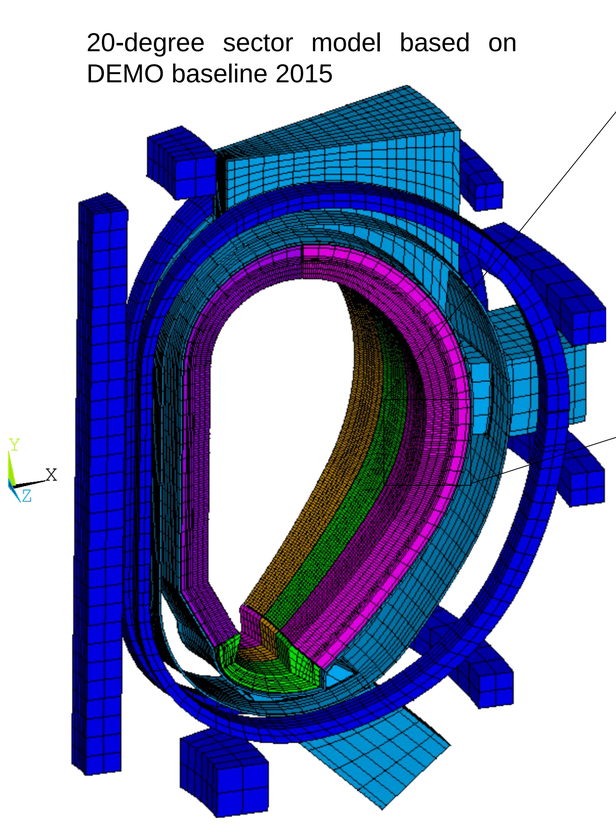
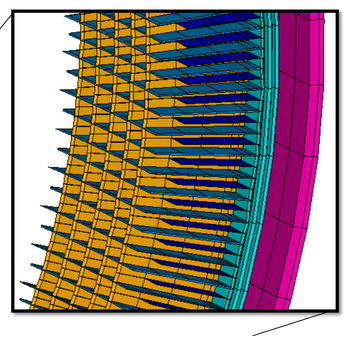
This work presents the development of a DEMO EM model based on the WCLL design able to evaluate EM loads during normal and off-normal operations. The model has the capability to use periodic boundary conditions and elements supporting non-linear magnetic properties. Eddy currents and related EM loads are calculated using ANSYS Emag and considering a VDE-up provided by CarMa0NL code with a 74 ms current quench time. Both the poloidal and toroidal field variations due to the plasma movement and to the current quench are implemented. The obtained results represent an important input for the structural assessment of the BB segments as well as for the definition of the attachment system with the VV.

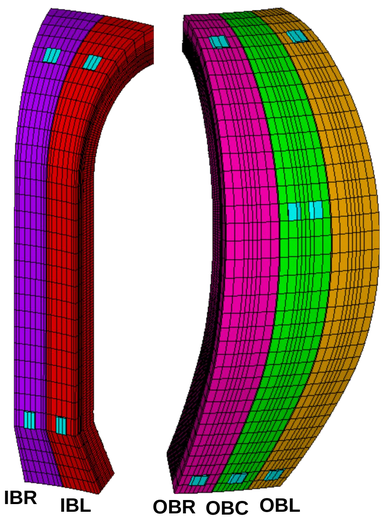
Electromagnetic FEM model

20-degree sector model based on DEMO baseline 2015





The internal structure of the WCLL design consisting in Pol-rad, Tor-rad and baffle plates has been implemented.

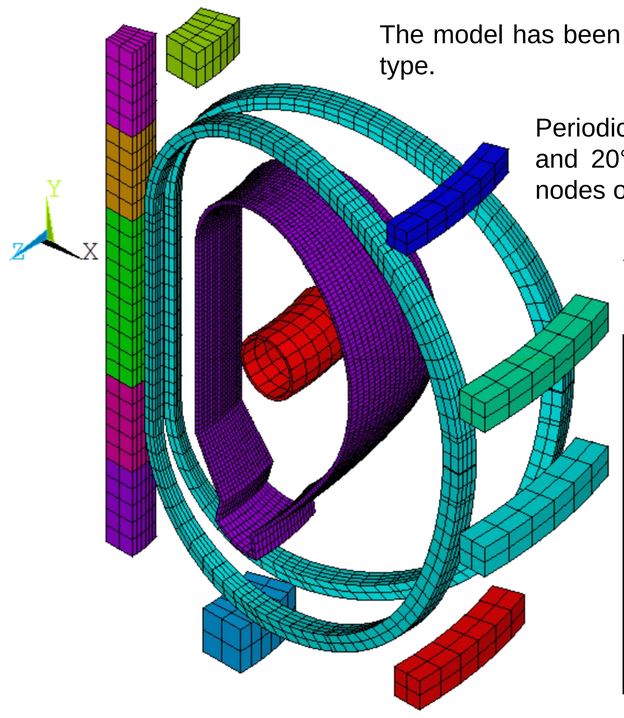


Averaged materials and EM properties have been used for the conductive components defined in the WCLL FEM model.

Material	PbLi	SS316	EUROFER97	EUROFER97	
Ref. Temp. (°C)	325	200	300	400	
Component Name					Resistivity (μΩ m)
VV		100%			0.867
BSS				100%	0.843
FW				85.7%	1.115
Caps			85.7%		0.983
Internal Plates			50%	50%	0.896
BZ	96.5%		1.5%		1.292
Manifold Walls			100%		0.843

Electrical connections between BBs and VV have been implemented at the top and bottom of the blanket structure following the design of the attachment system.

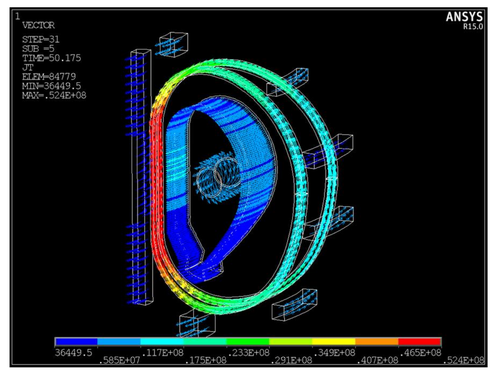
Loads and boundary conditions



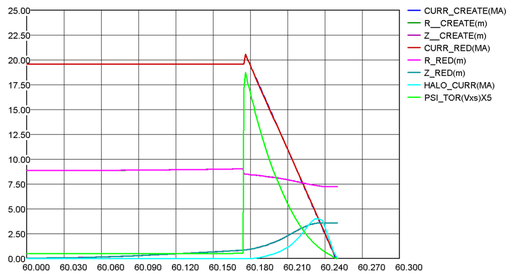
The model has been developed using the SOLID236 element type.

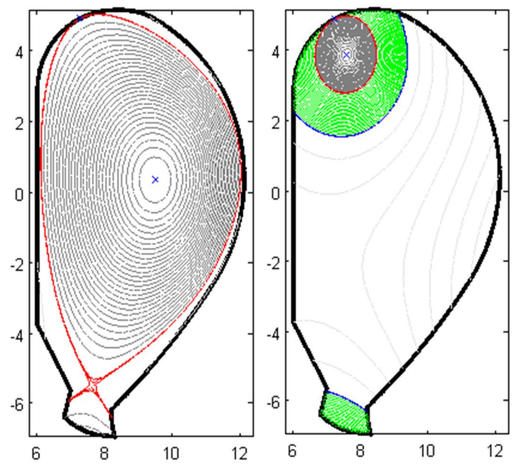
Periodicity is defined at the two cut planes (0° and 20°) by coupling the DOFs (Az, V) of the nodes on the two planes.

All the main sources of magnetic field have been implemented

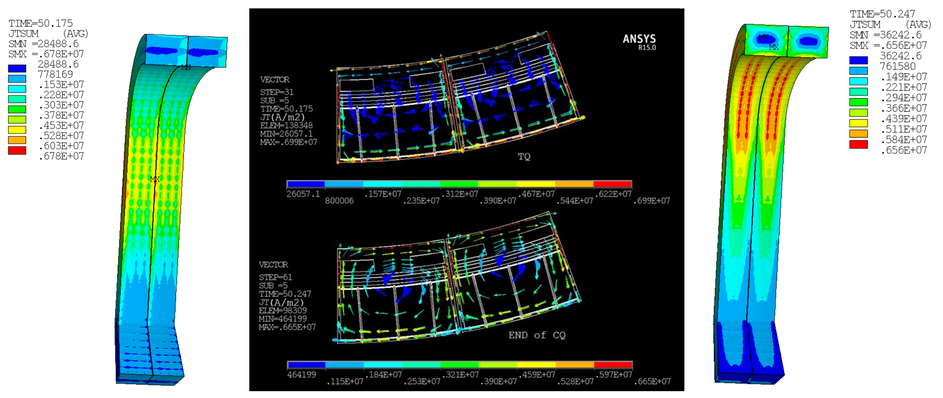


Poloidal coils' currents and plasma input (both poloidal and toroidal contribution) have been calculated by CarMa0NL code and provided for a VDE-up with a 74 ms current quench time.

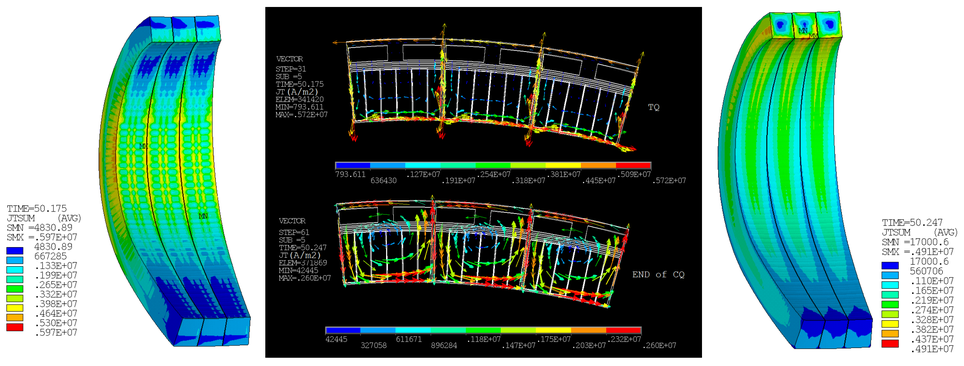




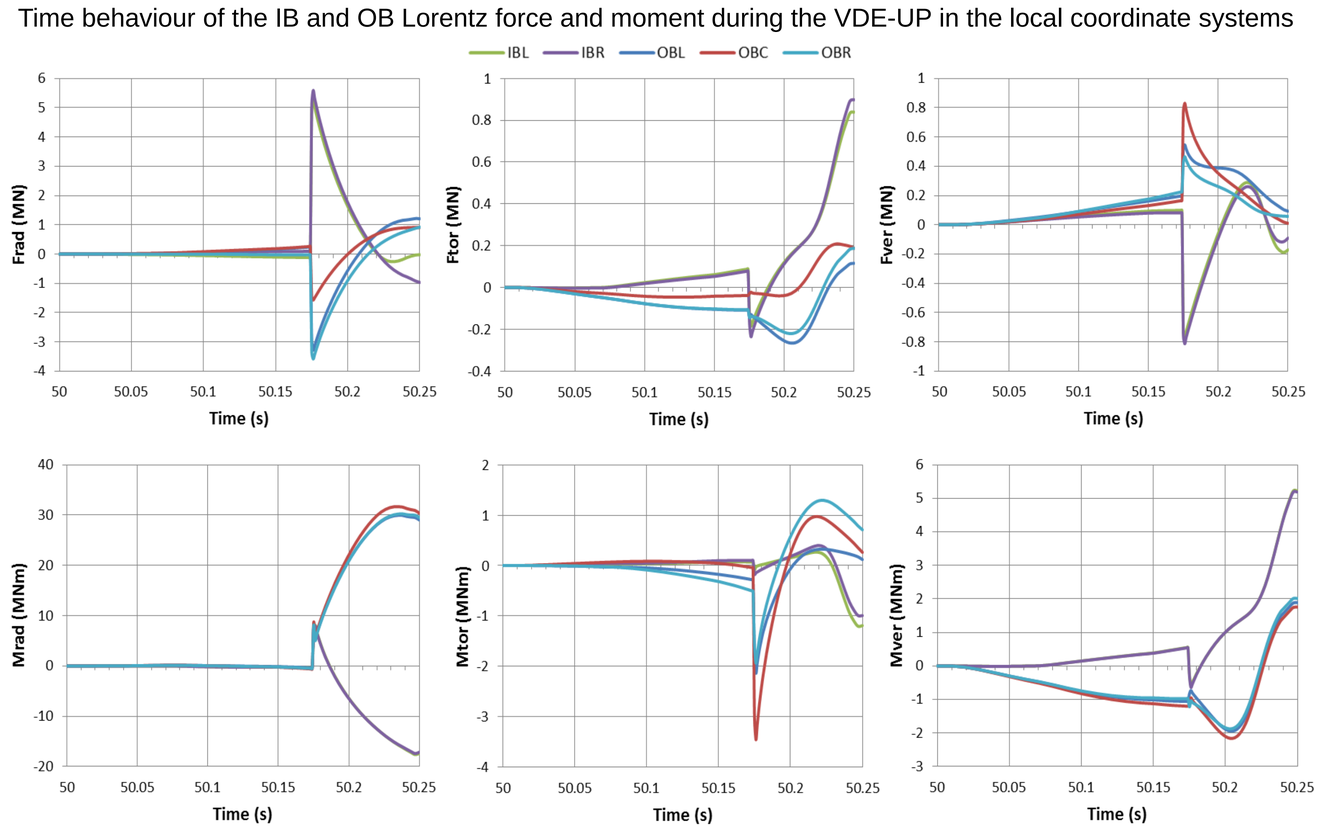
Results



IB and OB eddy current distribution at TQ peak and at the end of the CQ



Time behaviour of the IB and OB Lorentz force and moment during the VDE-UP in the local coordinate systems



KIT – The Research University in the Helmholtz Association

EUROfusion

This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 under grant agreement No 633053.
The views and opinions expressed herein do not necessarily reflect those of the European Commission.

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