



Structural assessment of contamination protection structure and bioshield roof

Nov. 2021

P.Marek, L.Ciupinski
(IPPLM - WUT)



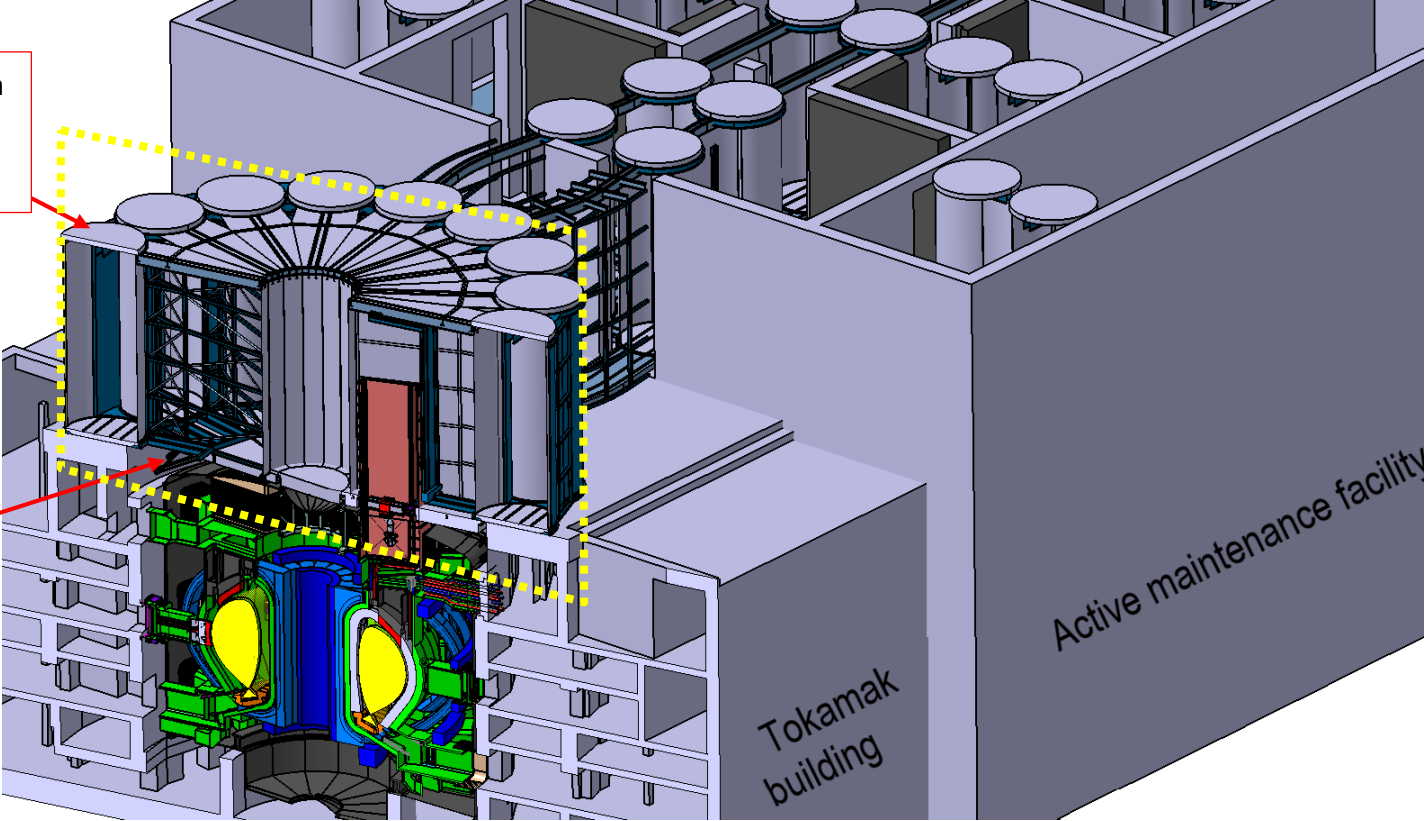
This work has been carried out within the framework of the EUROfusion Consortium and has received funding from the Euratom research and training programme 2014-2018 and 2019-2020 under grant agreement No 633053. The views and opinions expressed herein do not necessarily reflect those of the European Commission.

Section of tokamak complex

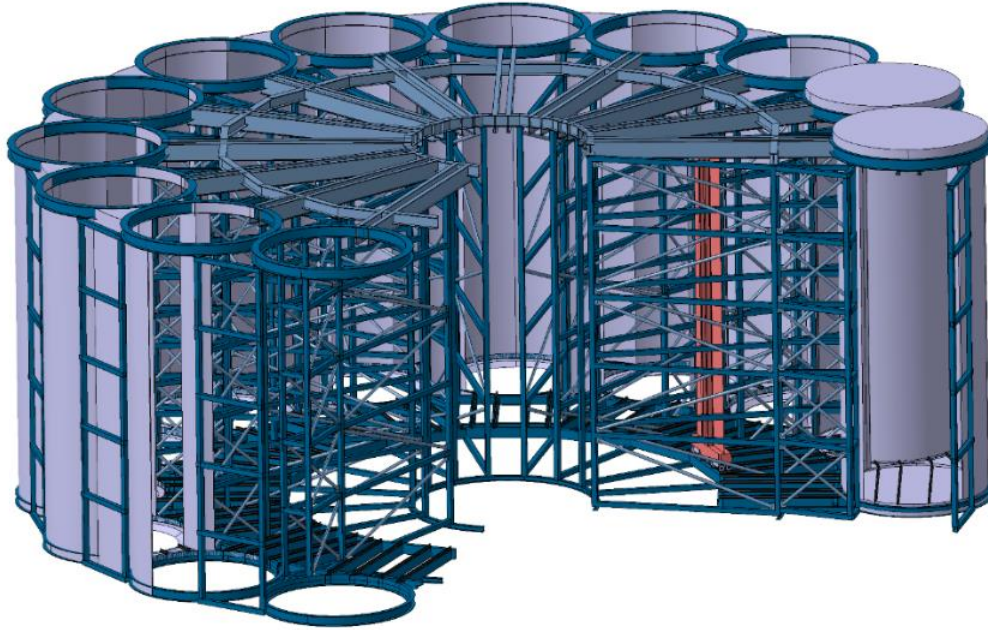


Contamination protection structure

Bioshield roof

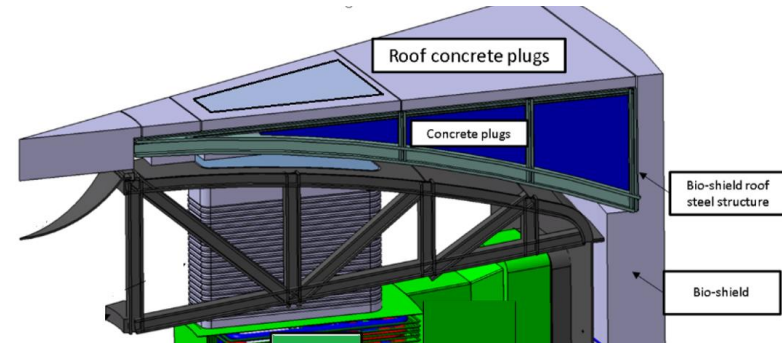


Contamination Protection Structure and Bioshield roof



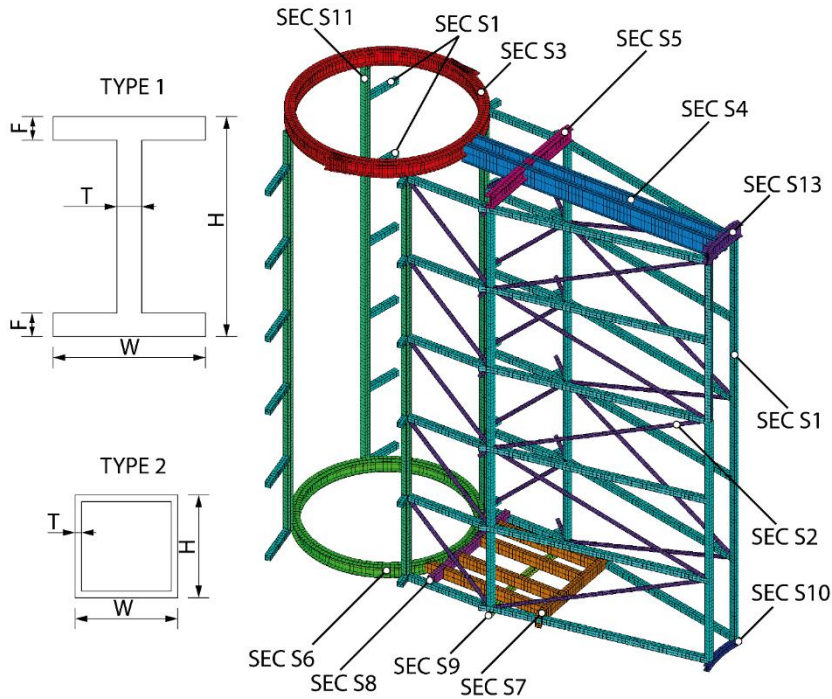
Aims of the task: 1) verify the structural integrity
2) propose necessary design improvements.

Design criteria: Eurocode 3 (EC3) for steel structures.

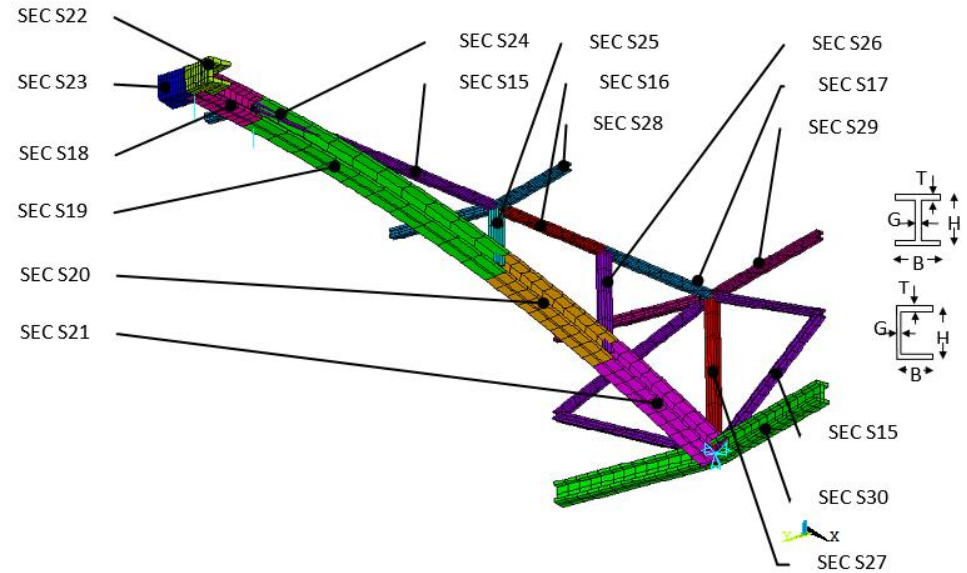


(Analysed in 2019)

FE parameterized model of the structure (beam elements)

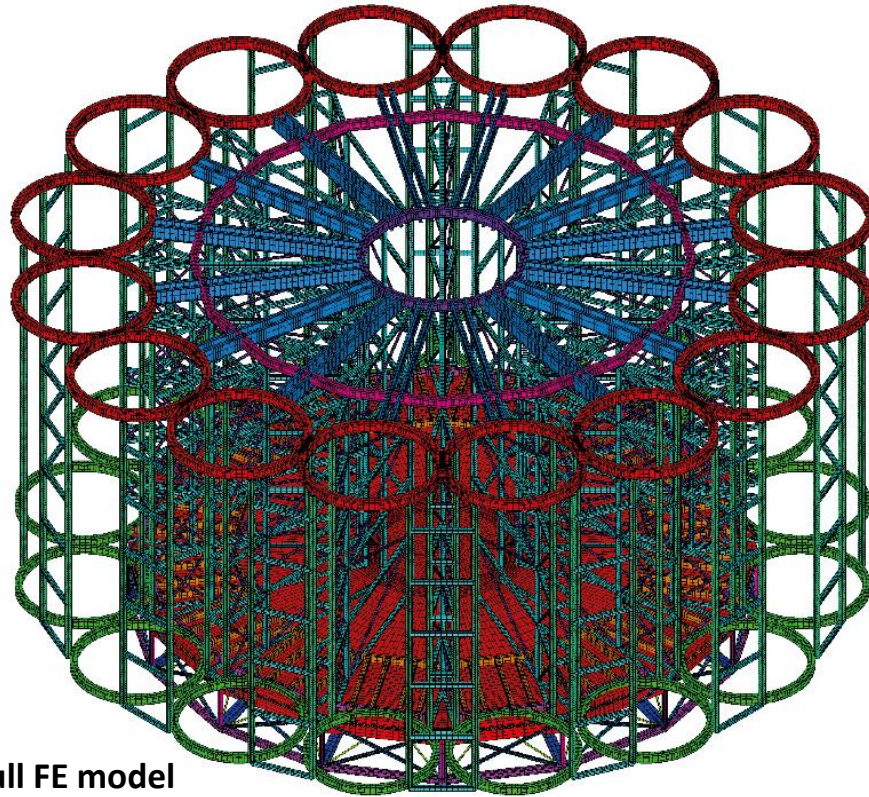


1/16 of the Contamination Protection Structure FE model

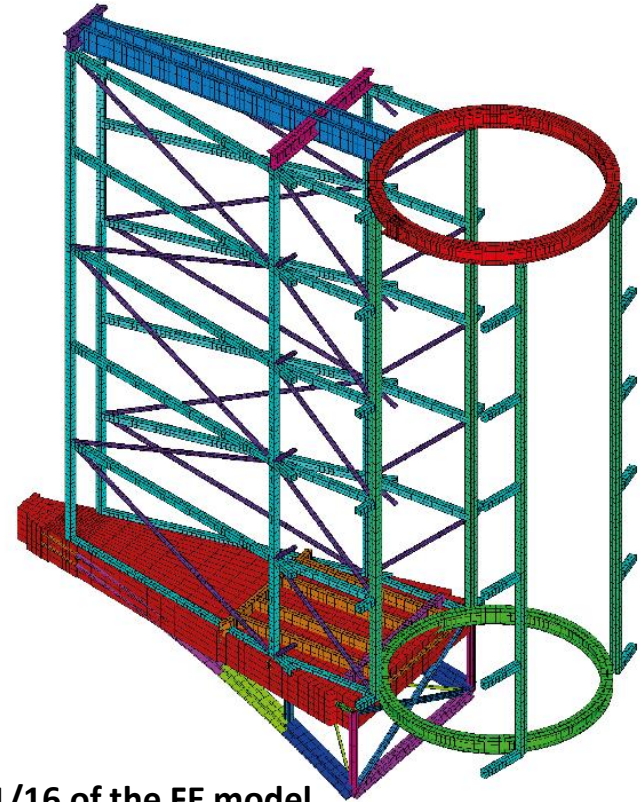


1/16 of the Bioshield roof FE model

FE model of entire structure (containment structure + bioshield roof)

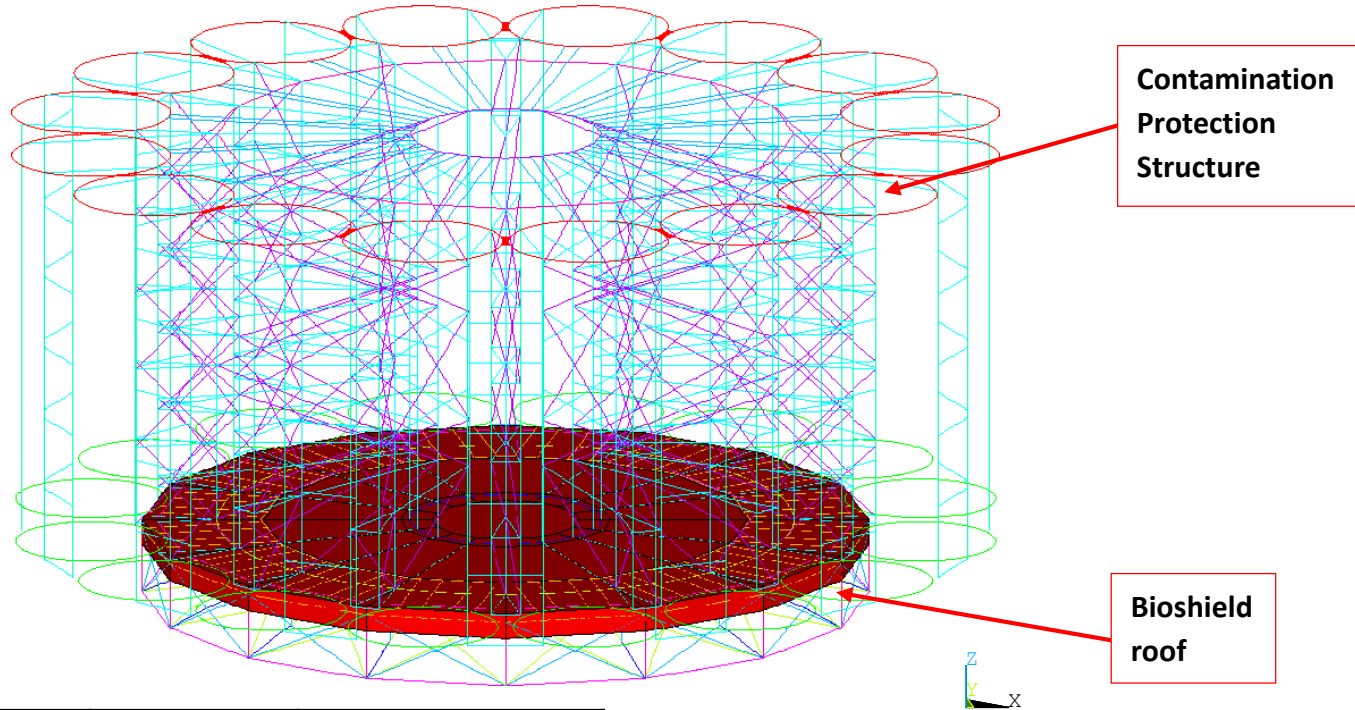


Full FE model



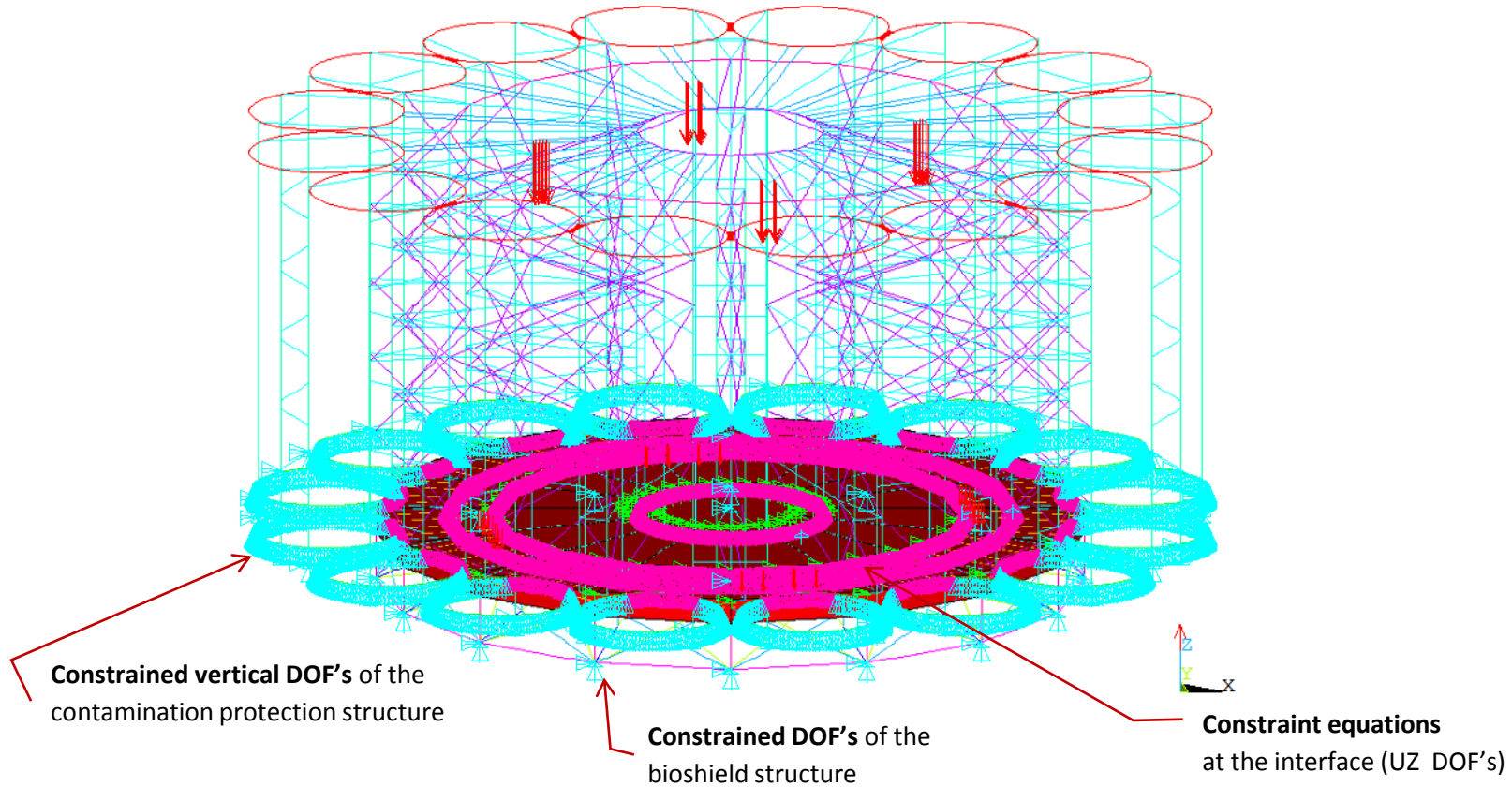
1/16 of the FE model

FE model of entire structure (containment structure + bioshield roof)

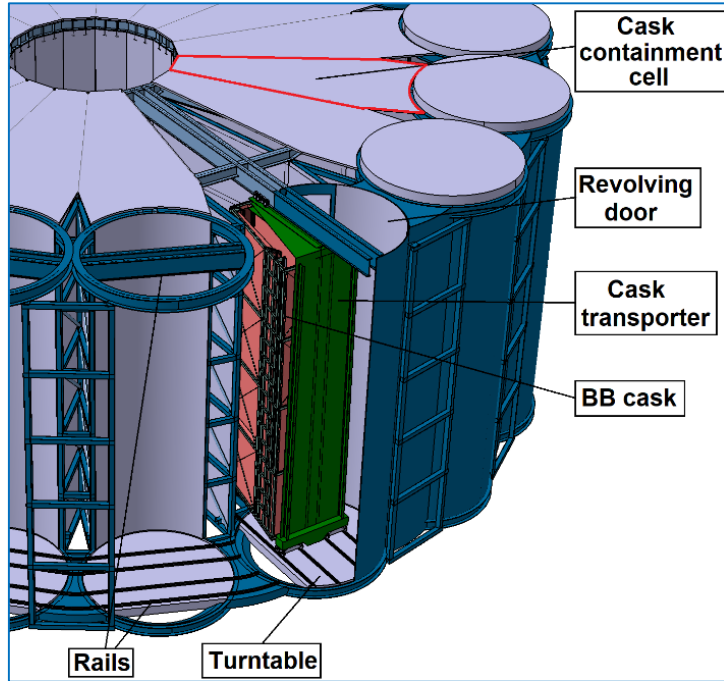


Element Type	Nodes	Name	Used in the mesh of
3D Structural Solid	8	SOLID185	All Solid components
3D Linear Beam	2	BEAM188	All Beam elements
Constraint element	2	MPC184	

FEM model of entire structure (Boundary conditions and constraints)



Load conditions and cask transporter configurations

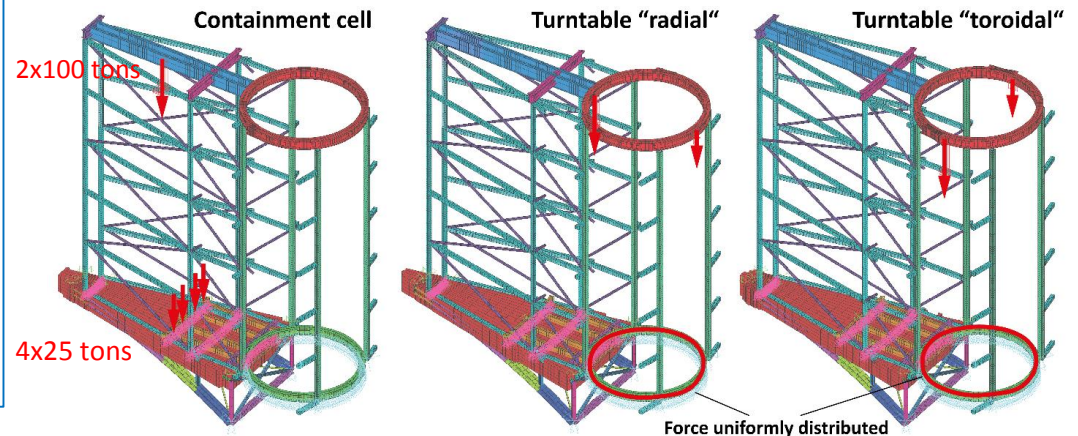


Load conditions:

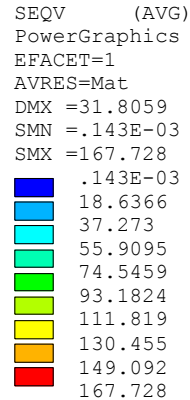
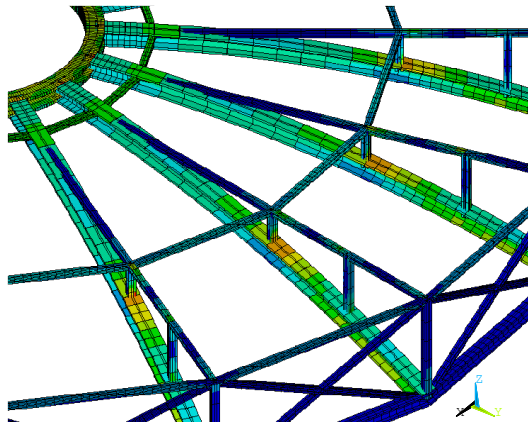
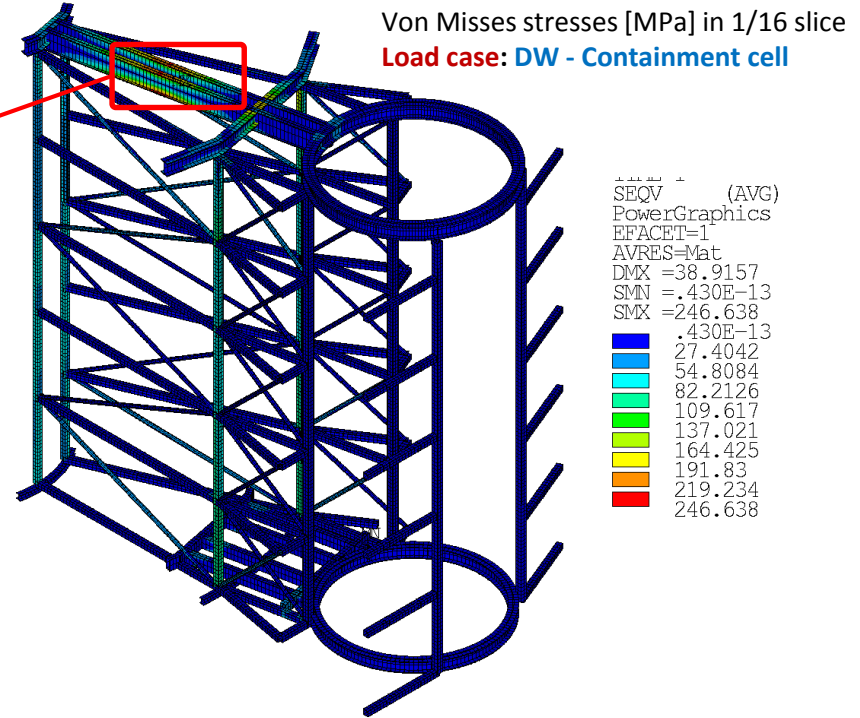
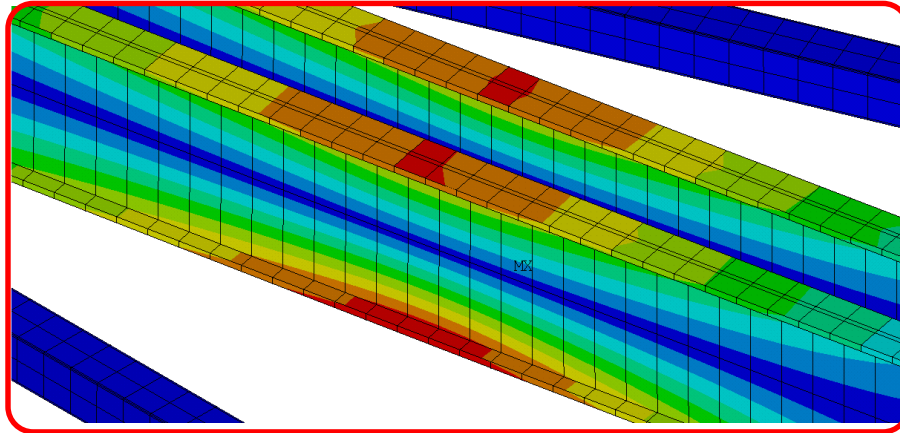
LC1 - $1.35 \cdot \text{gravity} + 1.5 \cdot \text{equipment}$

LC2 - $1.0 \cdot \text{gravity} + 1.0 \cdot \text{equipment} + 1.0 \cdot \text{SL-1}$

Cask transporter configurations:

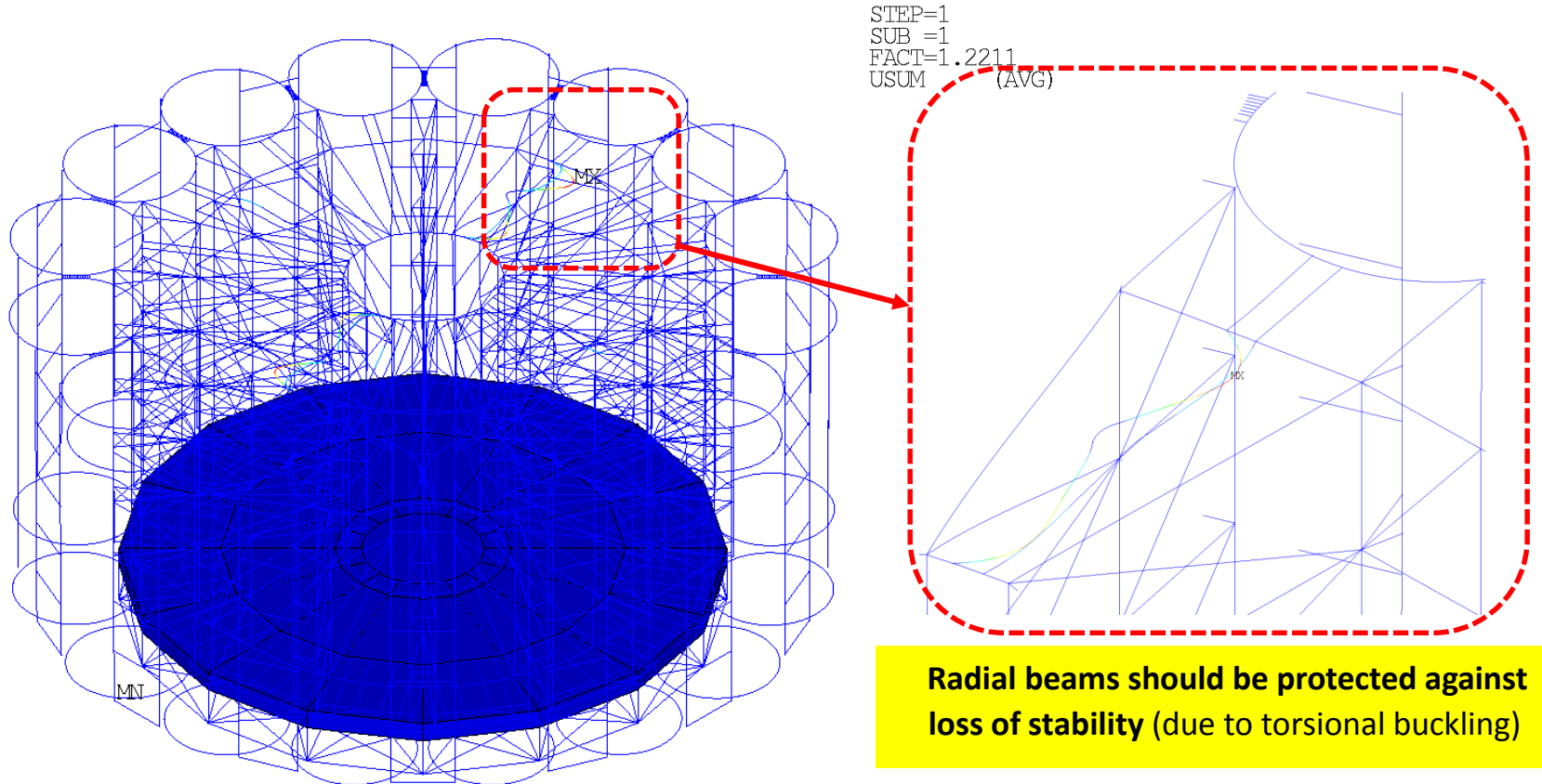


Results of linear static analysis



Stresses are in allowable limit

Results of linear buckling analysis





1. **Structural integrity has been verified using parametrized FE models (*Ansys APDL*)**
2. **Stress level is in an acceptable range (*below $f_{yk}/1.1 = 323\text{MPa}$*)**
3. **The structure is strong and rigid enough to withstand considered loads provided that the stability of the radial beams is improved**
4. **Loads acting on the bioshield roof structure turned out to be lower than those assumed during its preliminary design (2019)**

Mass estimation:

- Containment structure – **1849** tons
- Bioshield roof structure – **633** tons
- Concrete blocks – **5047** tons



Thank you for your attention