

A methodology for thermo-mechanical assessment of in-box LOCA events on fusion blankets and its application to EU DEMO HCPB breeding blanket

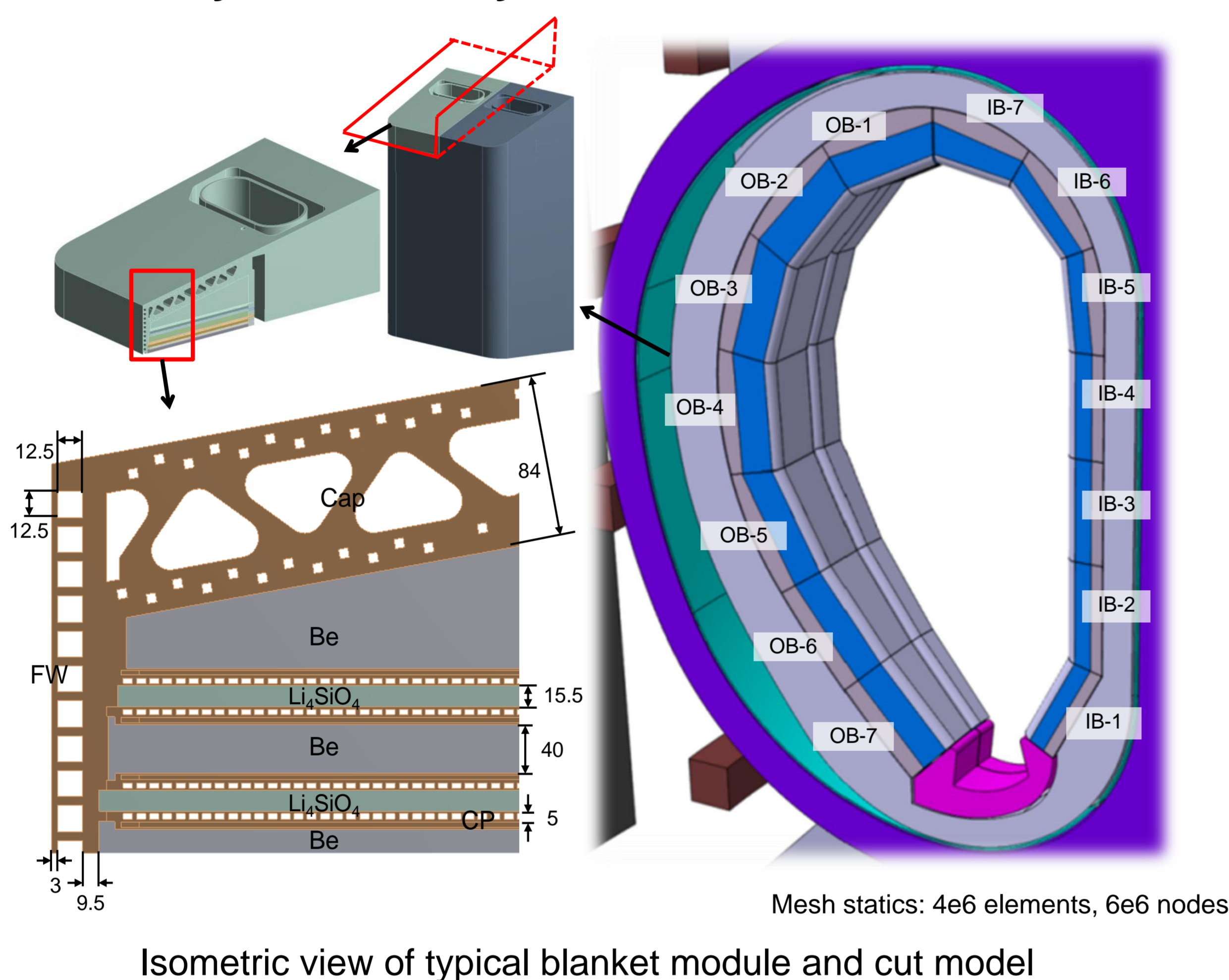
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Introduction

- A 3D model of EU DEMO HCPB breeding blanket has been developed for transient thermal analysis and structural analysis.
- Temperature evolution and stress field of HCPB breeding blanket under an in-box LOCA are obtained.
- New methodology is proposed for the thermo-mechanical assessment of HCPB breeding blanket under an in-box LOCA.

FEM Models

Geometry & Boundary conditions



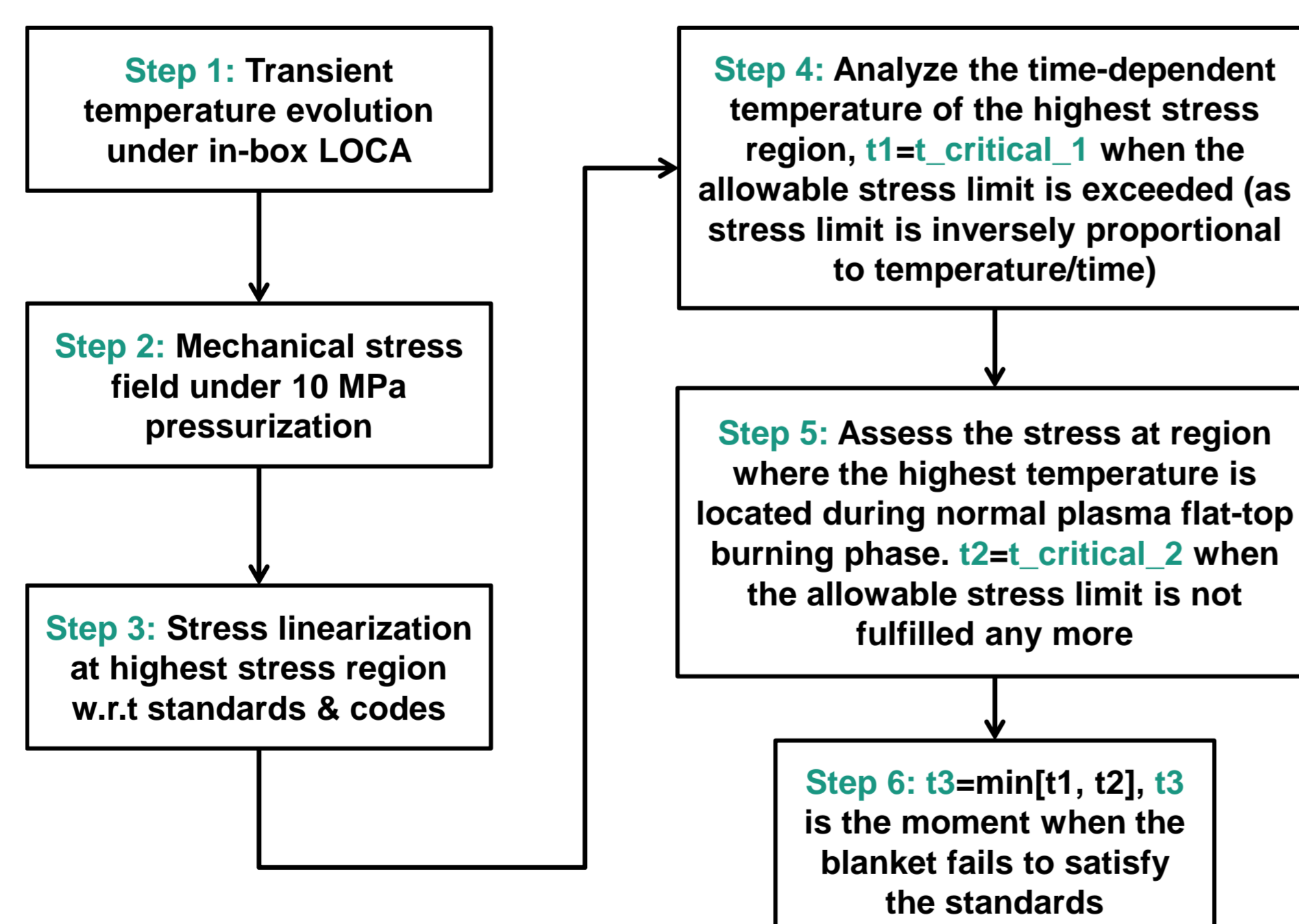
Transient thermal analysis

- Heat flux: 0.5 MW/m²
- No action is taken, when In-box LOCA occurs
- Thermal radiation from BLK to VV, only heat sink

Mechanical analysis

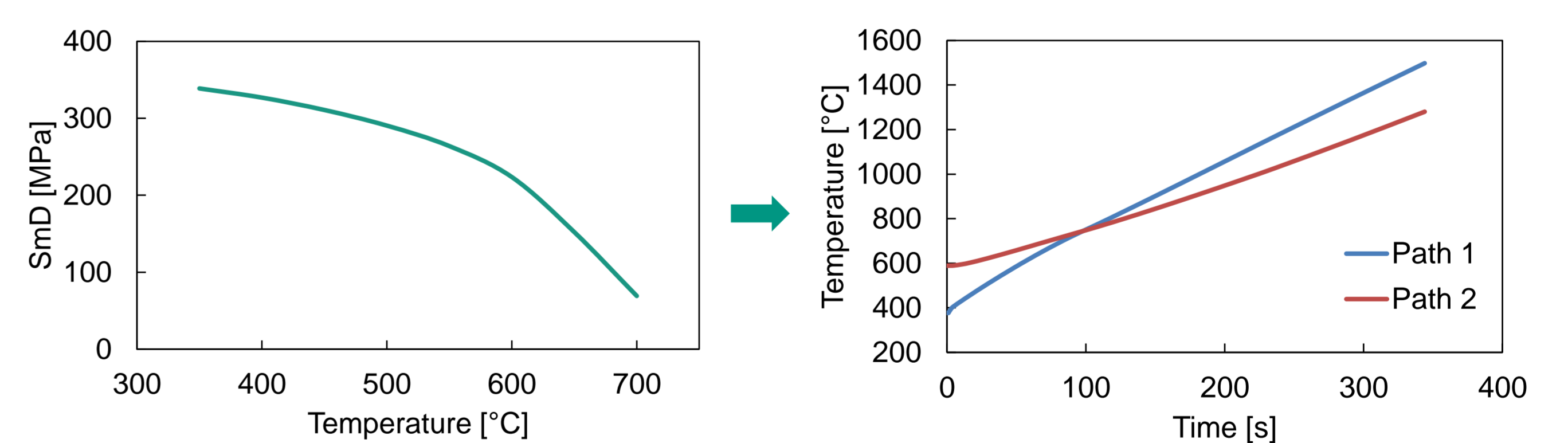
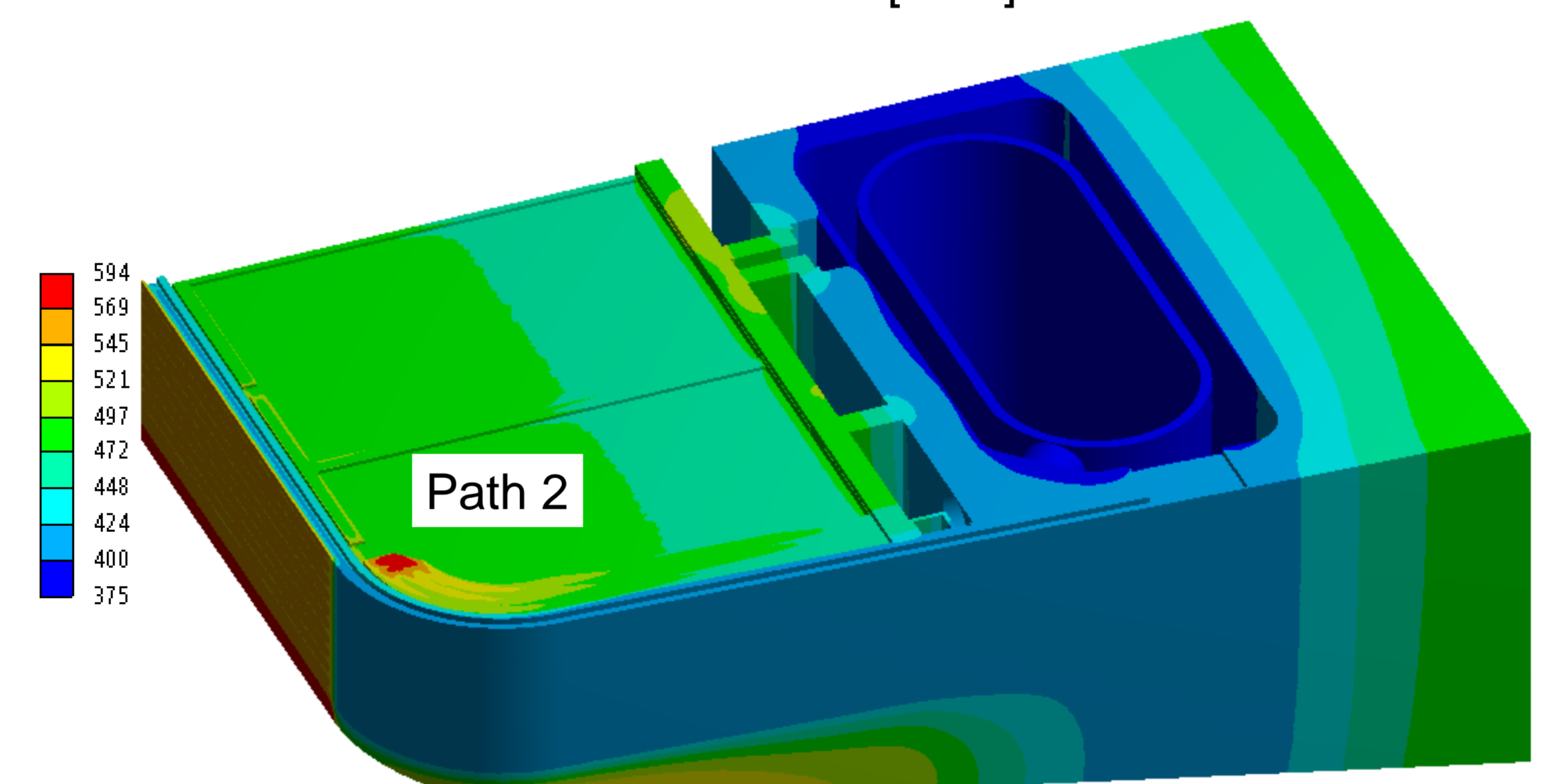
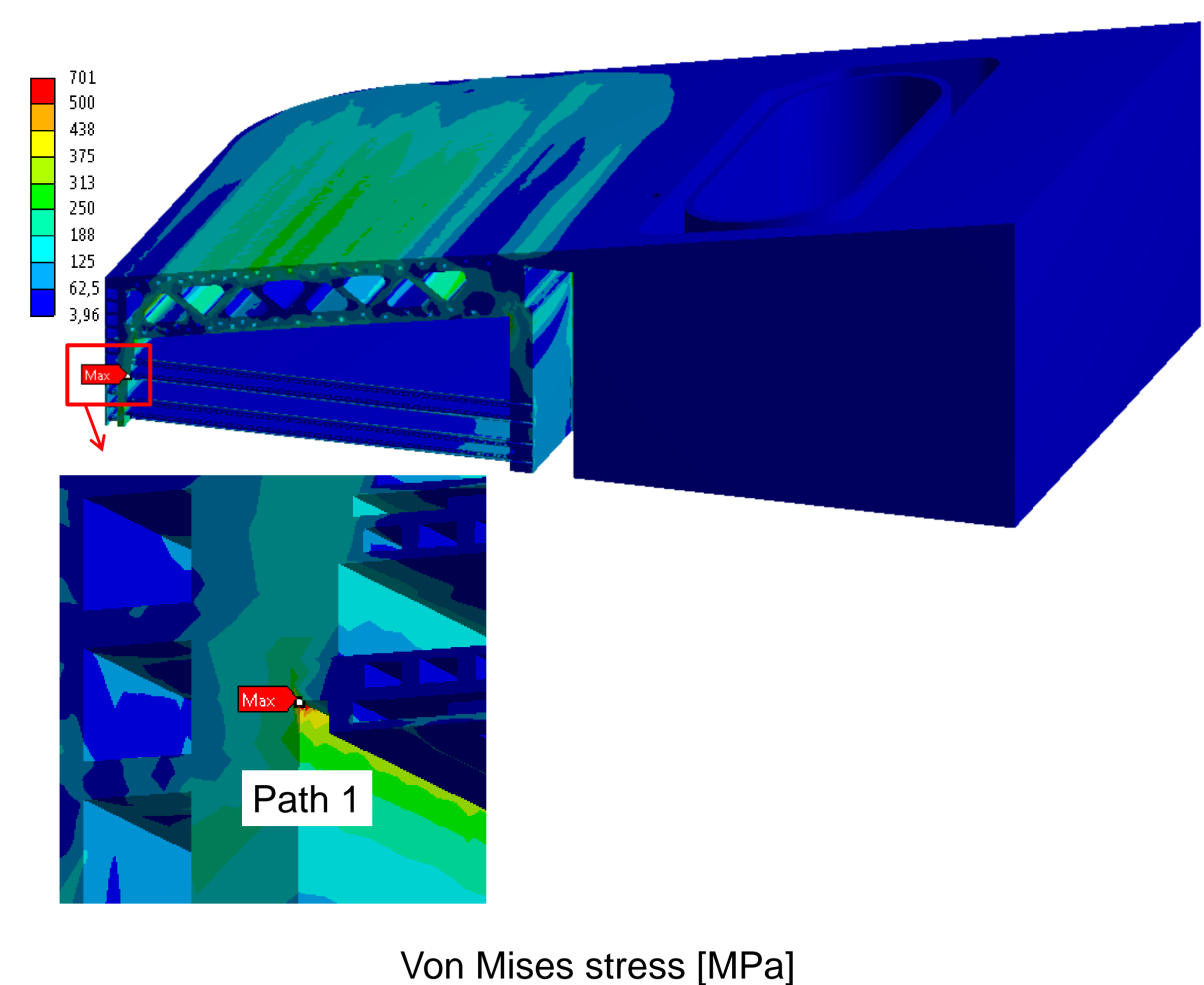
- Level D criteria, only P stress considered (RCC-MRx)
- 10 MPa applied on coolant channels, inner surfaces from inside blanket box

Proposed methodology



Note: Allowable stress S_m^D is dependent on temperature/time.

Results and Analysis



Stress limit as function of temperature

Temperature evolution at path 1 and 2

Table 1. Stress linearization at critical regions

MPa	IPC $\frac{P_m}{P_m}$	IPI $\frac{P_L + P_b}{P_L + P_b}$
Path 1	163	261
Path 2	42	87

$t_{\text{path 1}} = 64.1 \text{ s}$
 $t_{\text{path 2}} = 74.7 \text{ s}$
 $t_3 = \min[t_{\text{path 1}}, t_{\text{path 2}}]$

Conclusions

- Temperature evolution and stress field of EU HCPB breeding blanket under an in-box LOCA event are obtained by using ANSYS.
- New methodology is proposed and applied for the thermo-mechanical assessment of HCPB breeding blanket under an in-box LOCA.
- HCPB breeding blanket can survive the in-box LOCA up to about 64 s without mitigation action, which is long enough to trigger plasma shutdown.

