

LOCA and LOFA Analysis for ARIES-AT

E. A. Mogahed, L. El-Guebaly, A. Abdou, and P. Wilson

**Fusion Technology Institute
University of Wisconsin-Madison**

**With input from
M. Sawan and D. Henderson**

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http://fti.neep.wisc.edu/FTI/ARIES/JUN2000/loca_eam.pdf



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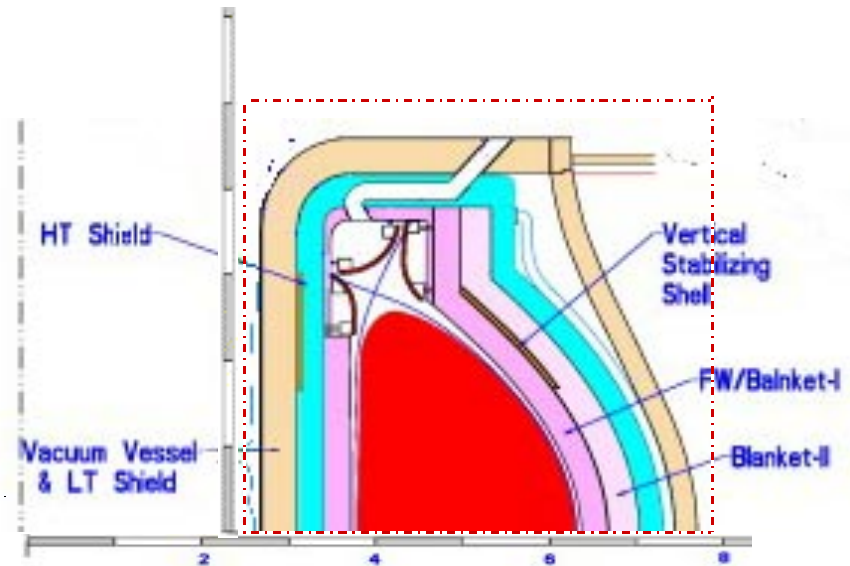
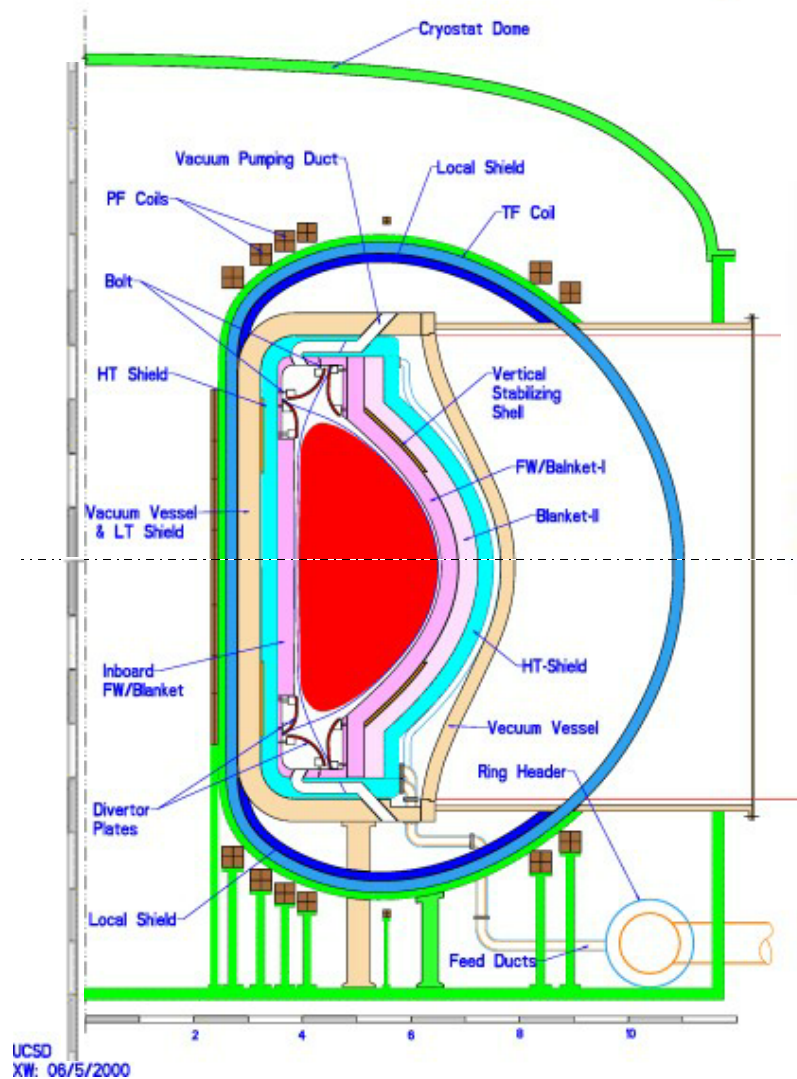


Introduction

- This analysis addresses the rare events of loss of coolant accident (LOCA) and loss of flow accident (LOFA) during the first week following the accident.
- The analysis is performed for a base configuration specific to ARIES-AT.



Cross Section of ARIES-AT Power Core Configuration



- The Upper Half of the ARIES-AT Power Core is Considered for the Thermal Finite Element Model.



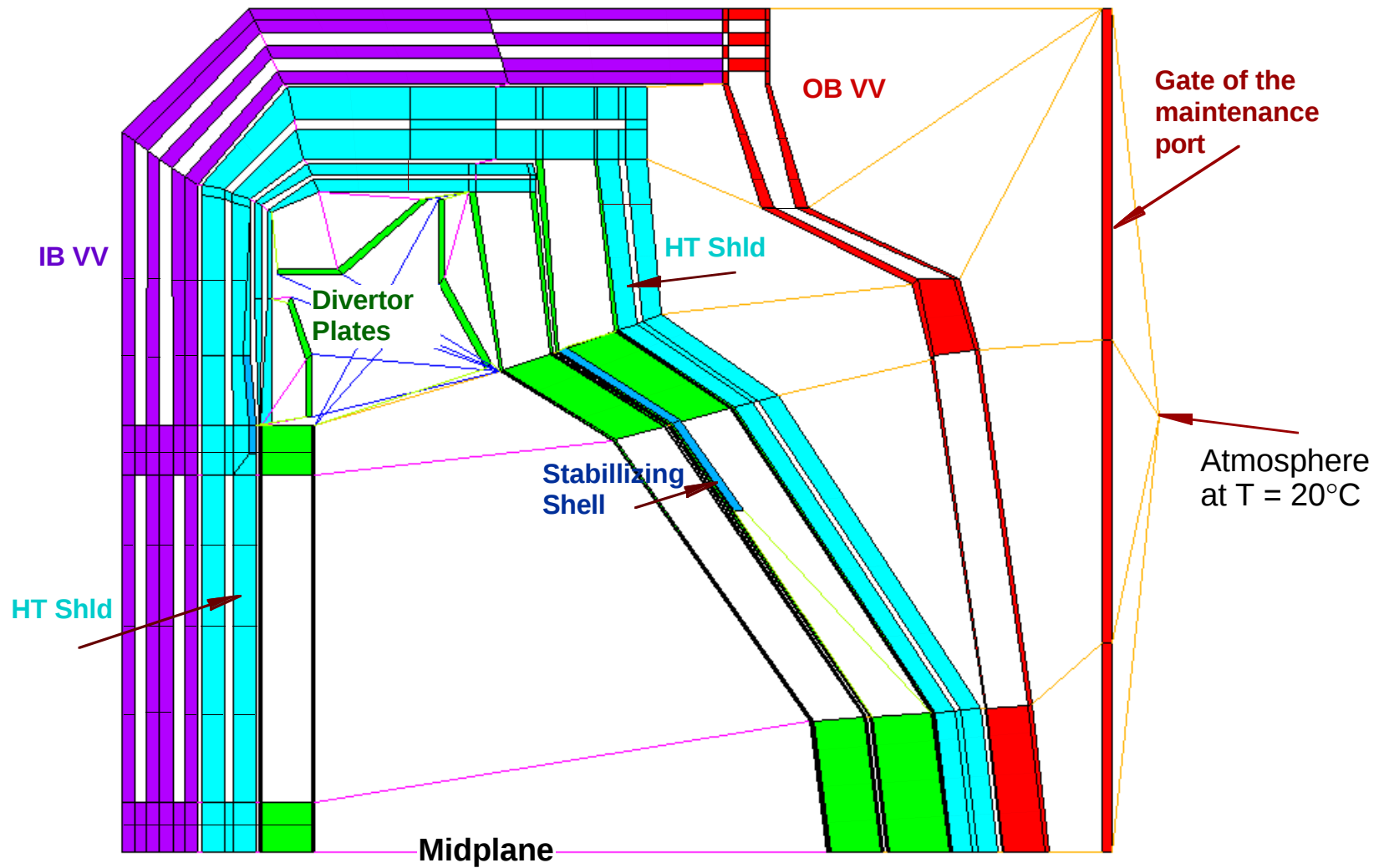
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Finite-Element Model

- A transient axisymmetric finite-element model in r-z plane is constructed to study ARIES-AT LOCA/LOFA events.
- The analysis was done for the upper half only, the divertor plates and 4 cm W vertical stabilizing shells are included.
- ANSYS 5.4 code is used to perform this analysis.



Finite-Element Model



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Assumptions, Initial and Boundary Conditions

Due to the large difference between the time scale of plasma shutdown (10-20 s) and the loss of coolant or flow loss (several minutes-hours), it is assumed that the plasma is immediately quenched at the onset of the LOCA/LOFA and the chamber components' temperature begins to increase due to the decay heat generated (worst case scenario).



* The base case assumes:

- 1- Adiabatic boundary conditions at the inner surface of the I/B VV.
- 2- The outer surface of the O/B VV radiates to the gate of the maintenance port.
- 3- The maintenance port convects (naturally) to the atmosphere at 20°C.
- 4- Thermal radiation is allowed in the gaps between surfaces.



Average Temperature at Onset of LOCA/LOFA in °C

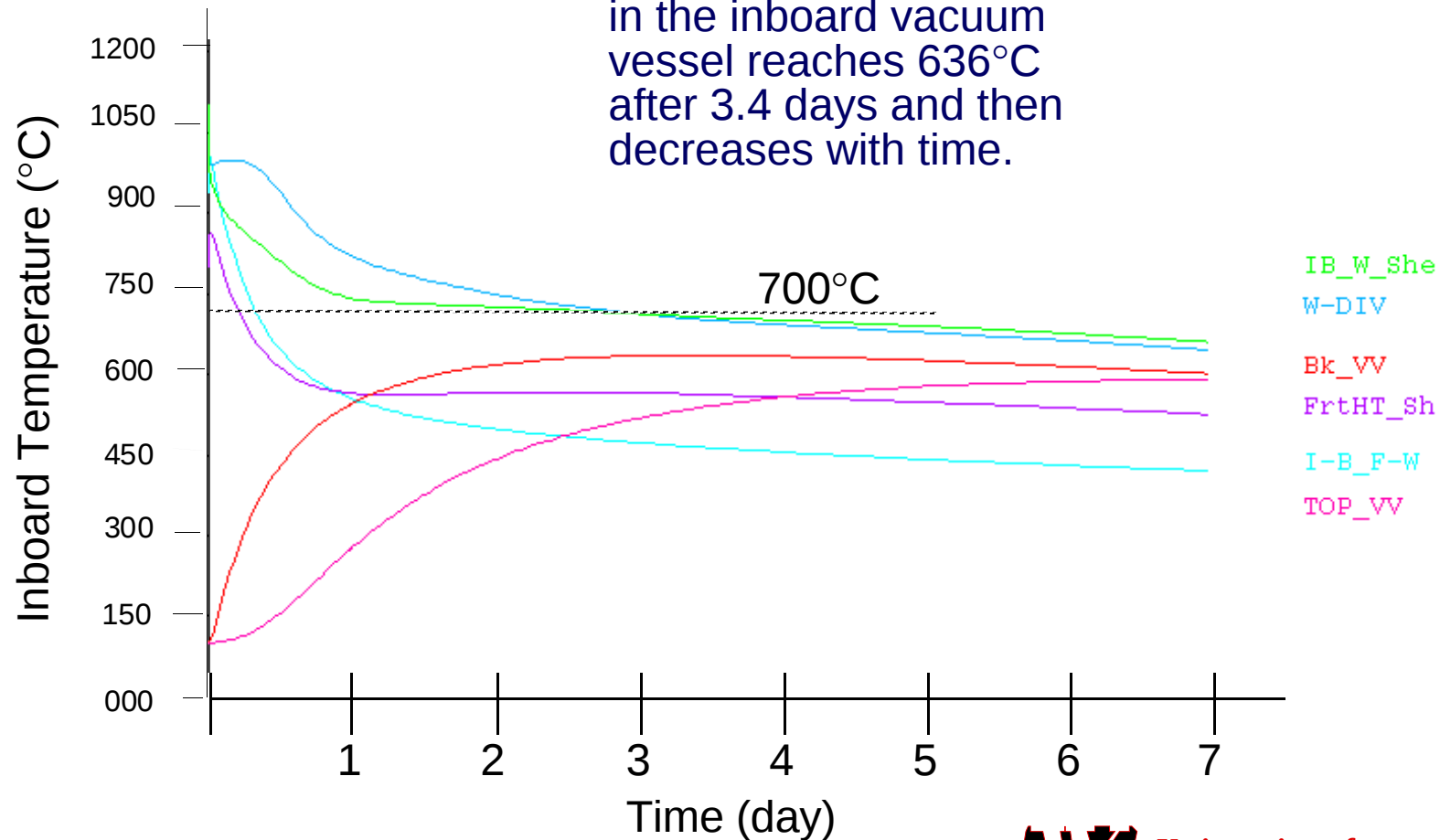
	Coolant	Structure
Inboard Components: -----		
LT shield & V.V.	75	100
HT shield	759	806
Blanket	968	925 for side SiC walls
First wall	800	960 for front wall 925 for back wall
Outboard components: -----		
Blanket-I: Wall	787	950 for front wall 925 for back wall
Blanket-I	965	925 for side SiC walls
Blanket-II: Wall/blanket	709	800 for front/back wall
Blanket-II	932	800 for side SiC walls
HT shield	725	800
V.V.	75	100



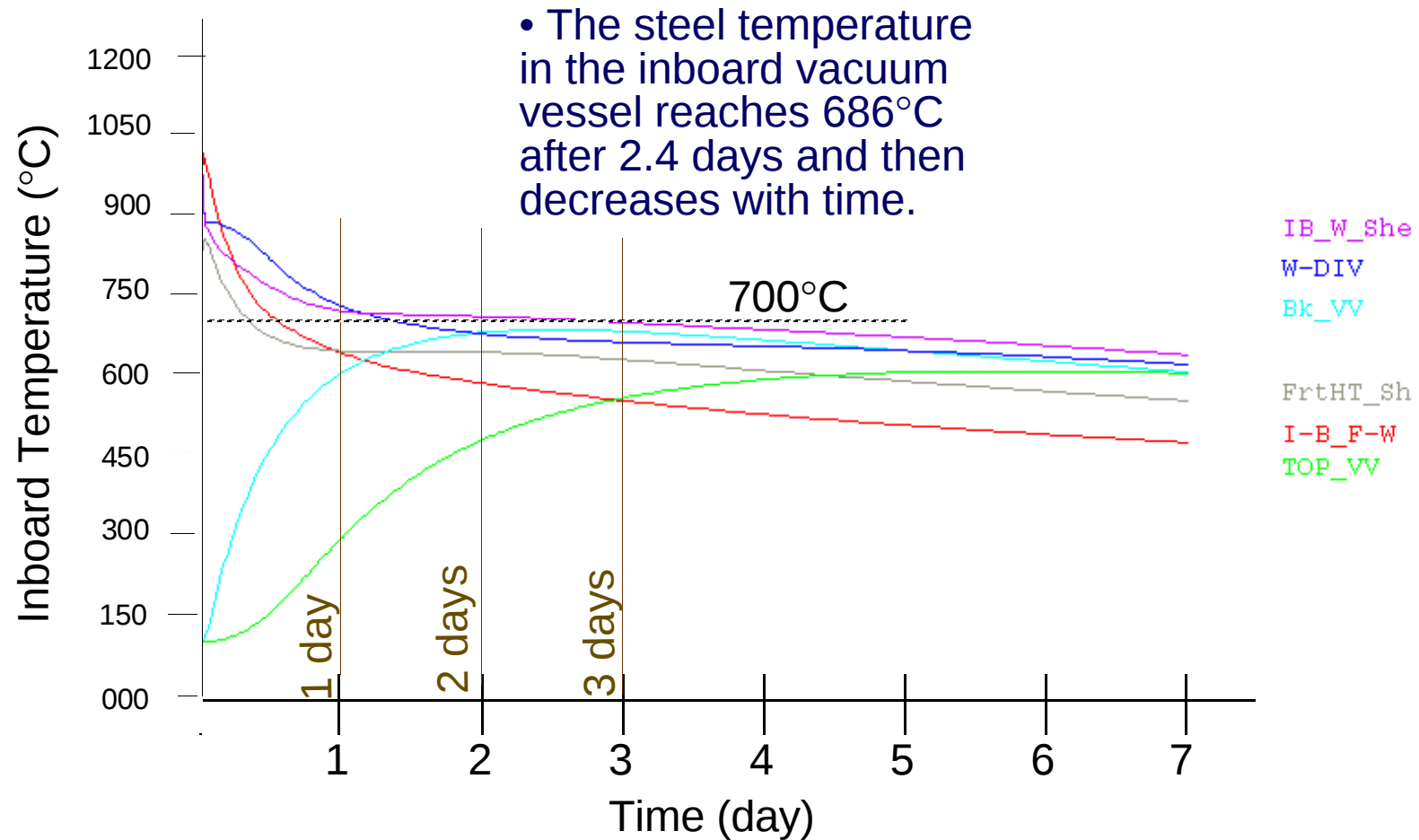
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Inboard LOCA Temperature History of Some Key Components

- The steel temperature in the inboard vacuum vessel reaches 636°C after 3.4 days and then decreases with time.

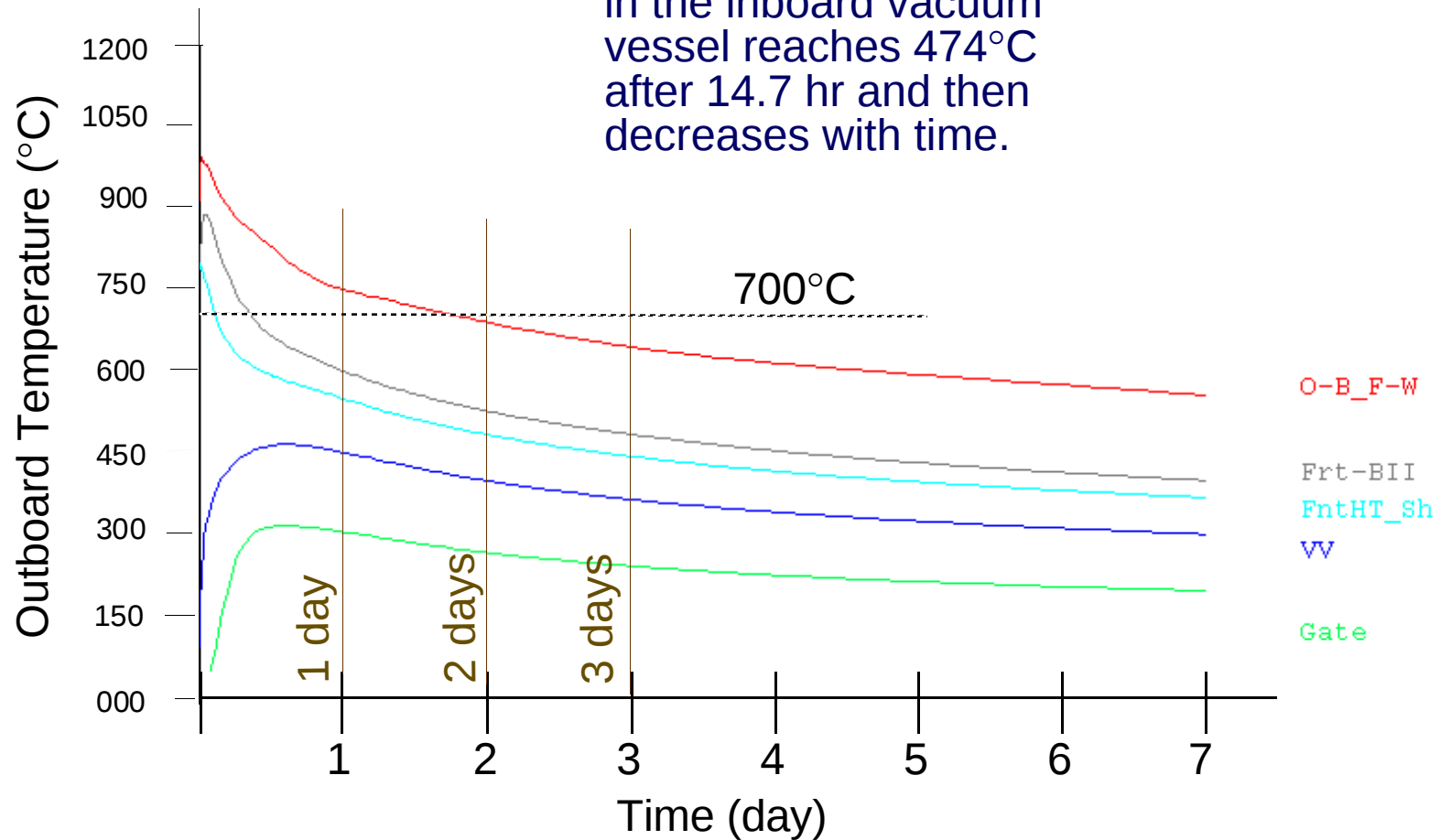


Inboard LOFA Temperature History of Some Key Components

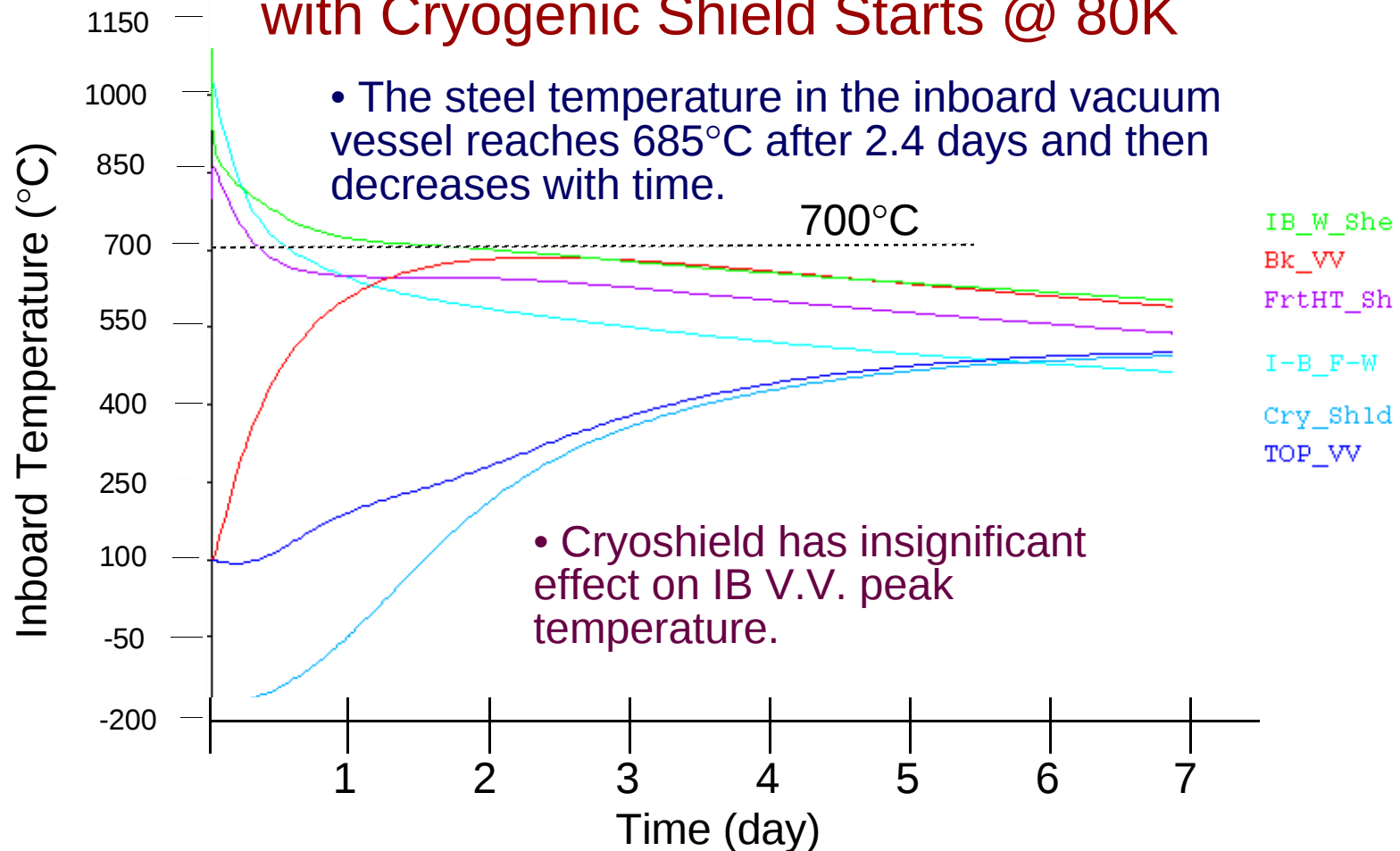


Outboard LOFA Temperature History of Some Key Components

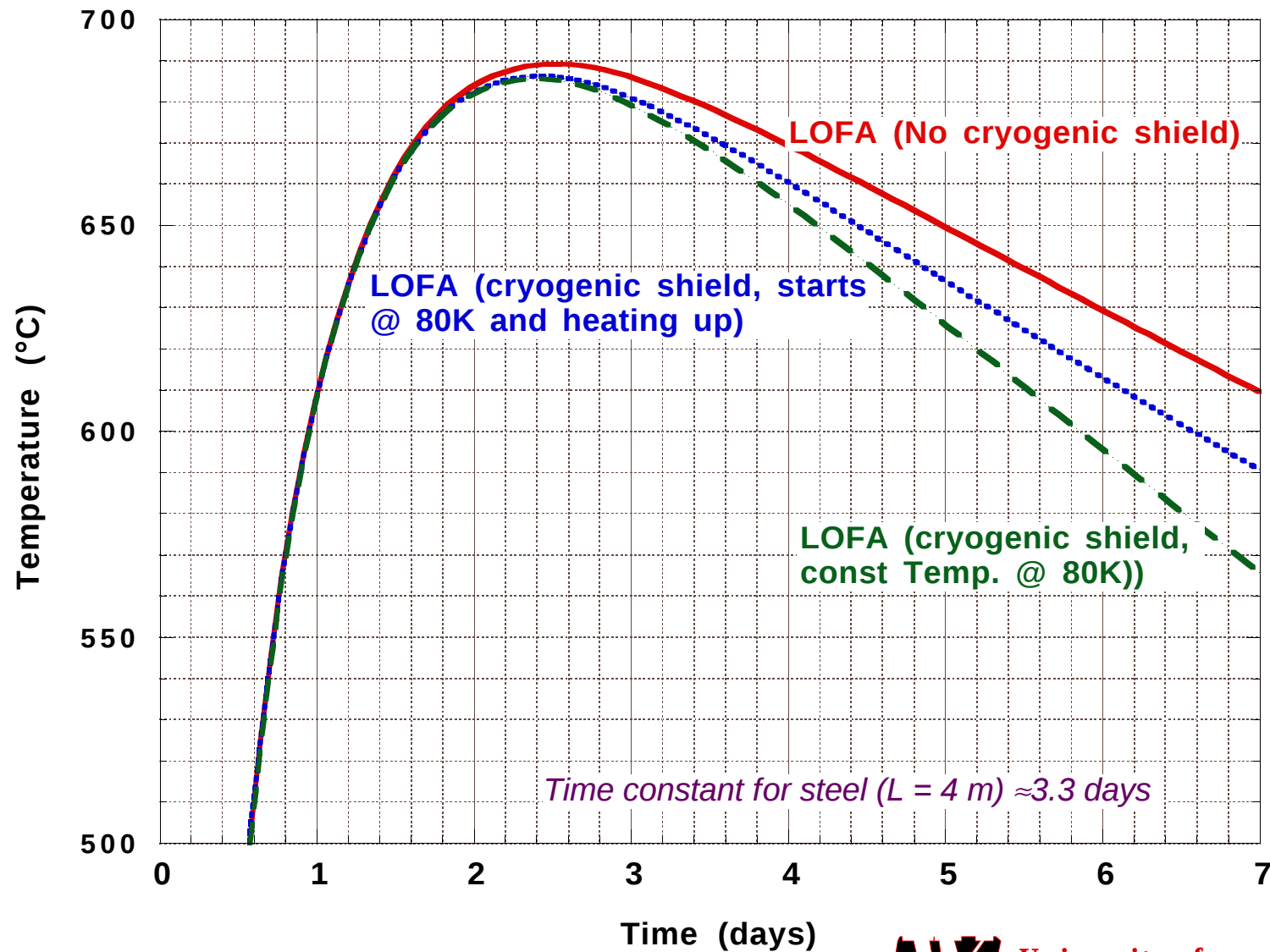
- The steel temperature in the inboard vacuum vessel reaches 474°C after 14.7 hr and then decreases with time.



Inboard LOFA Temperature History of Some Key Components with Cryogenic Shield Starts @ 80K

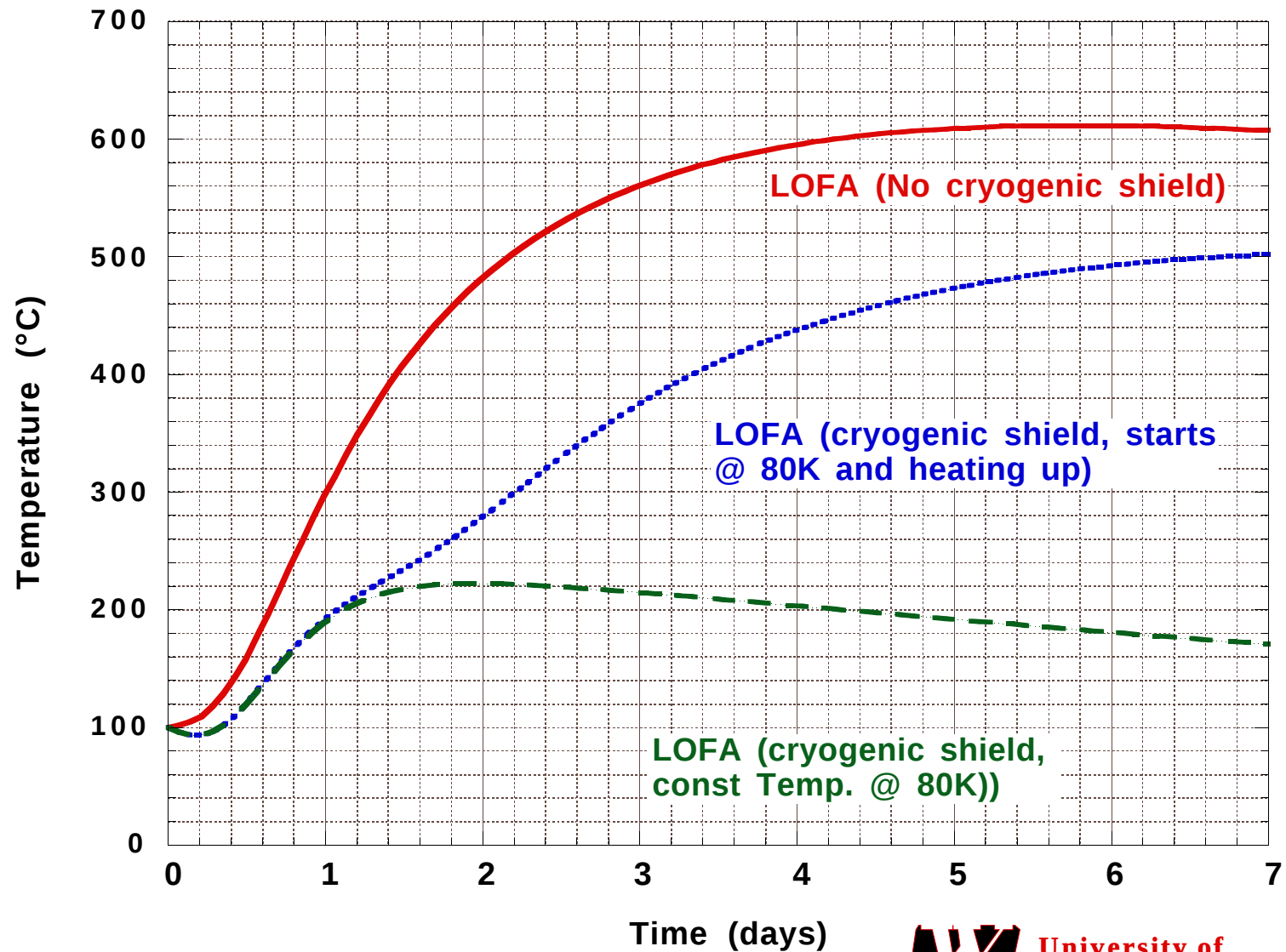


Temperature Comparison of the Back of VV at the Midplane



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Temperature Comparison of the Top of VV



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Summary of the Results

Temperature (°C) in the I/B vacuum vessel at the midplane ($T_{\text{initial}} = 100^{\circ}\text{C}$)

Case	1 day	2 days	3 days	7 days
1 - Complete LOCA (in LiPb & Water)	543.8°C	617.4°C	<u>634.6°C</u>	<u>601.5°C</u>
2 - LOFA in LiPb & LOCA in Water	608°C	683.9°C	<u>685.9°C</u>	<u>669.4°C</u>
3 - LOFA in LiPb & LOCA in Water (with Cryogenic Shield)	607.9°C	<u>682.2°C</u>	<u>680.9°C</u>	590.5°C

Temperature (°C) in the I/B vacuum vessel at the midplane ($T_{\text{initial}} = 50^{\circ}\text{C}$)

1 - Complete LOCA (in LiPb & Water)	512.3°C	591.2°C	<u>611.5°C</u>	<u>586.3°C</u>
2 - LOFA in LiPb & LOCA in Water	581°C	665.5°C	<u>671.9°C</u>	<u>601.7°C</u>



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Conclusions

- Worst case scenario is total LOFA in LiPb and total LOCA in water
- SiC components have an acceptable temperature during full LOCA/LOFA ($T_{\max} < 1100^{\circ}\text{C}$).
- IB V.V. exhibits the highest LOCA/LOFA temperature among all FS components ($T_{\max} < 700^{\circ}\text{C}$).
- With no heat sink on IB side, maximum IB V.V. LOCA/LOFA temperature reaches 689°C in ~ 2.5 days.
- Partial LOCA/LOFA (in one loop or more) will result in lower temperatures.
- No need for a special procedure to deal with LOCA/LOFA

