

# **LOCA/LOFA Analyses for LiPb/FS System**

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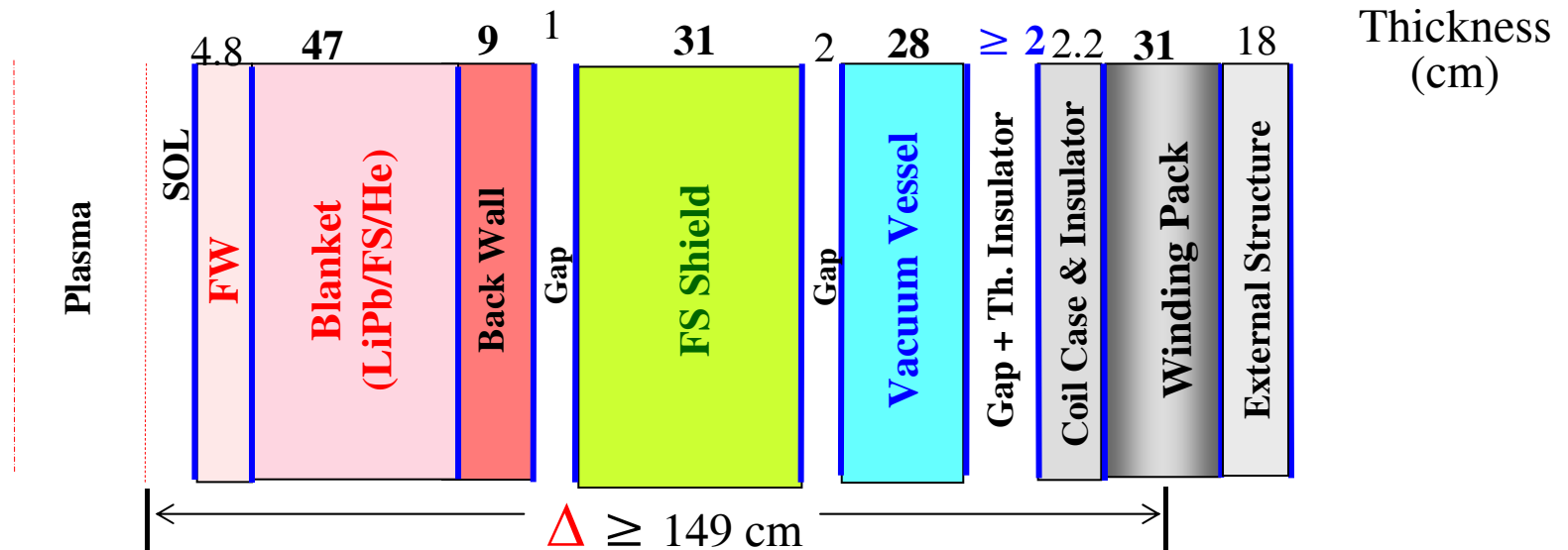
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# **LOCA/LOFA Analysis Update**

- 1. Description of the thermal models, boundary conditions, and assumptions used for the LOCA/LOFA analyses.**
- 2. Update of results presented previously to include plasma / nuclear heating for 3 seconds after loss of coolant.**
- 3. LOCA/LOFA analysis with new Li/Pb afterheat data.**
- 4. Modeling in progress to include support structure.**

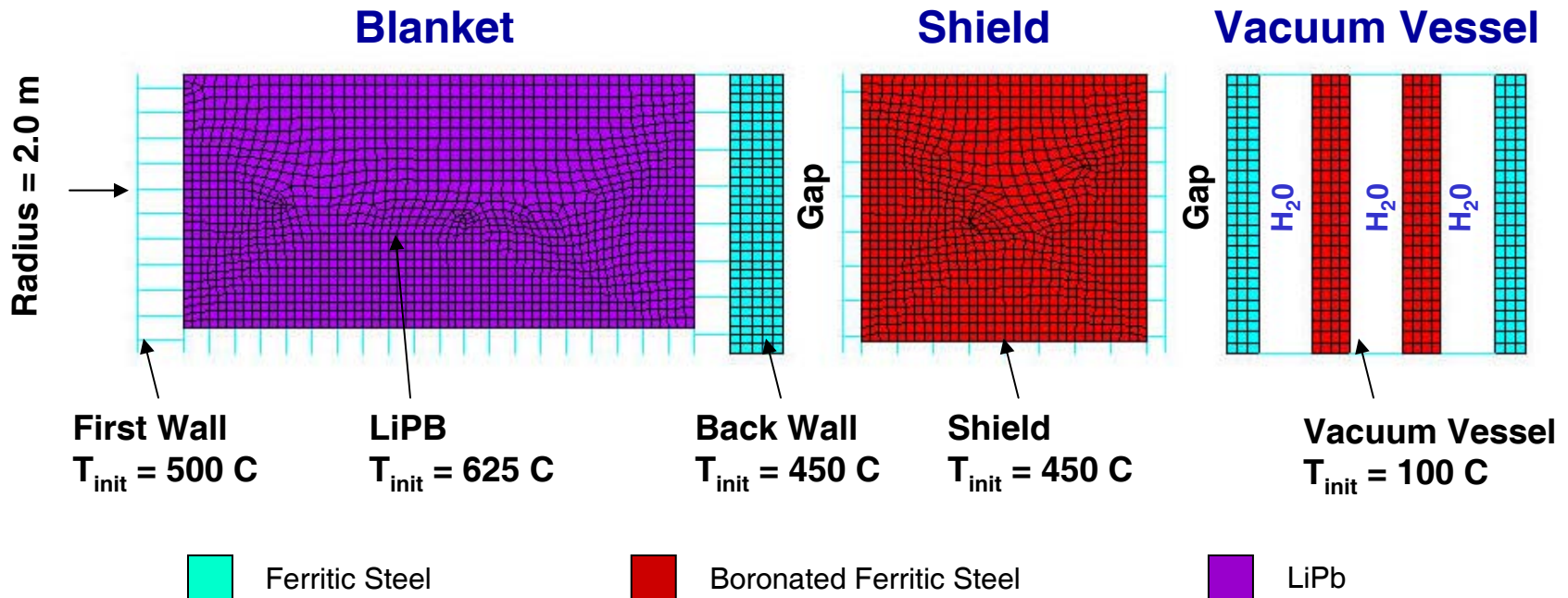
# LiPb/FS/He Radial Build (Water Cooled Internal VV)

- These LOCA/LOFA analyses assume perfect insulation between the vacuum vessel and the coil case, i.e. no heat loss.
- Also, no support structure in gaps included.



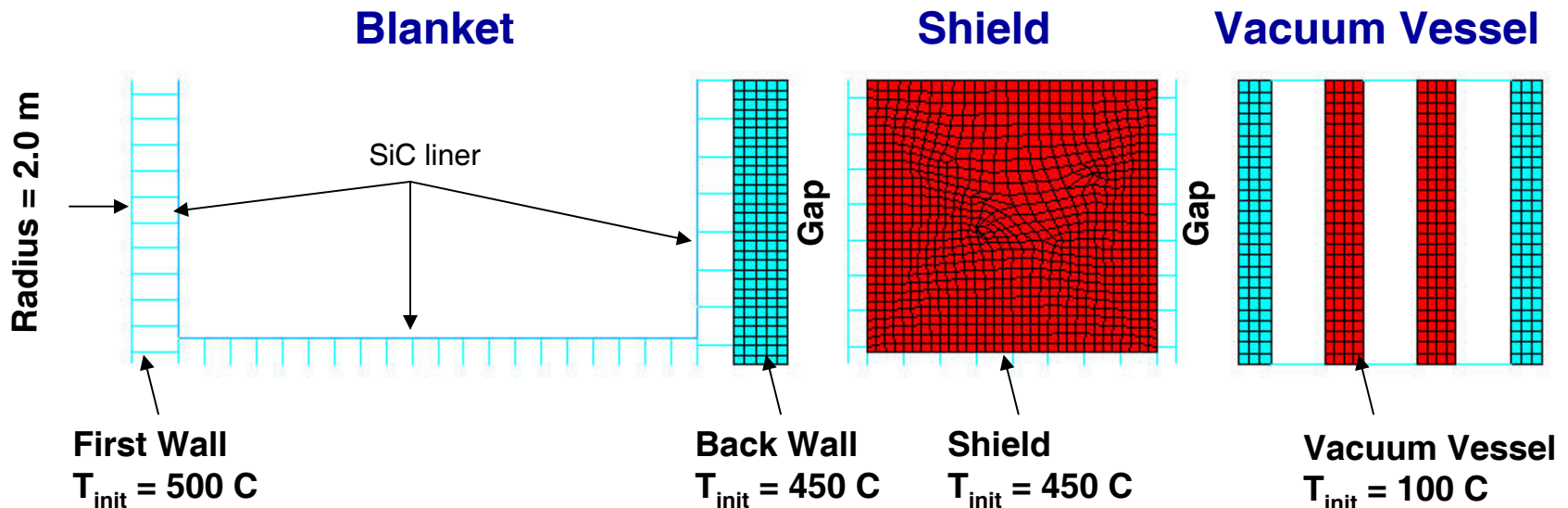
# ANSYS FE Model and Boundary Conditions for Thermal Analyses

- Adiabatic boundary at back of vacuum vessel
- Model is axisymmetric about plasma centerline and symmetric on sides
- **Emissivity of 0.3** assumed across vacuum gaps and vacated cooling channels
- All analyses assume there is no helium in channels



# Analyses without LiPb in Blanket Including Surface and Nuclear Heating

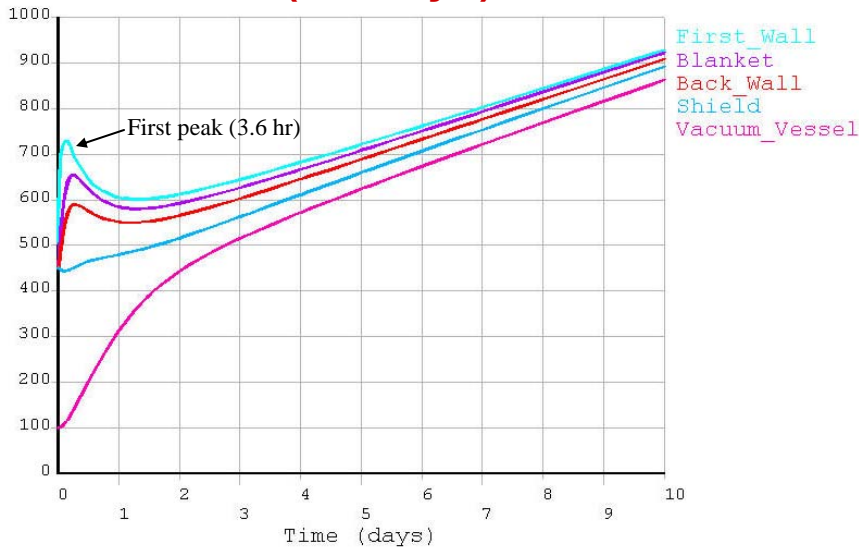
- Surface and nuclear heating continues for three seconds after loss of coolant
- First case assumes loss of all coolants – complete LOCA



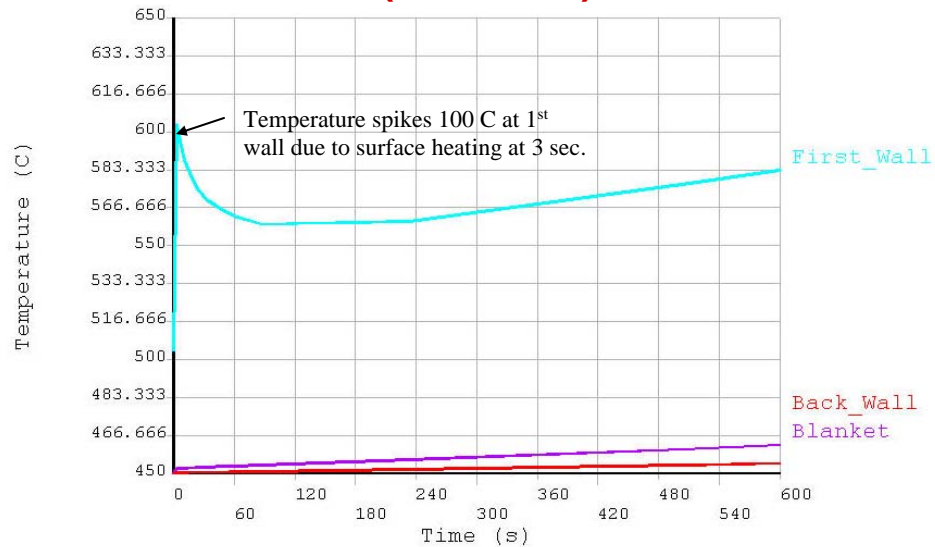
# Complete LOCA Thermal Response

- Without coolant or heat loss, temperature continues to rise.
- Surface and nuclear heating have little long term effect. Long term temperature rise increases by 0.2 C. First peak temperature increases by 2.6 C.

## Long Term Response (10 Days)



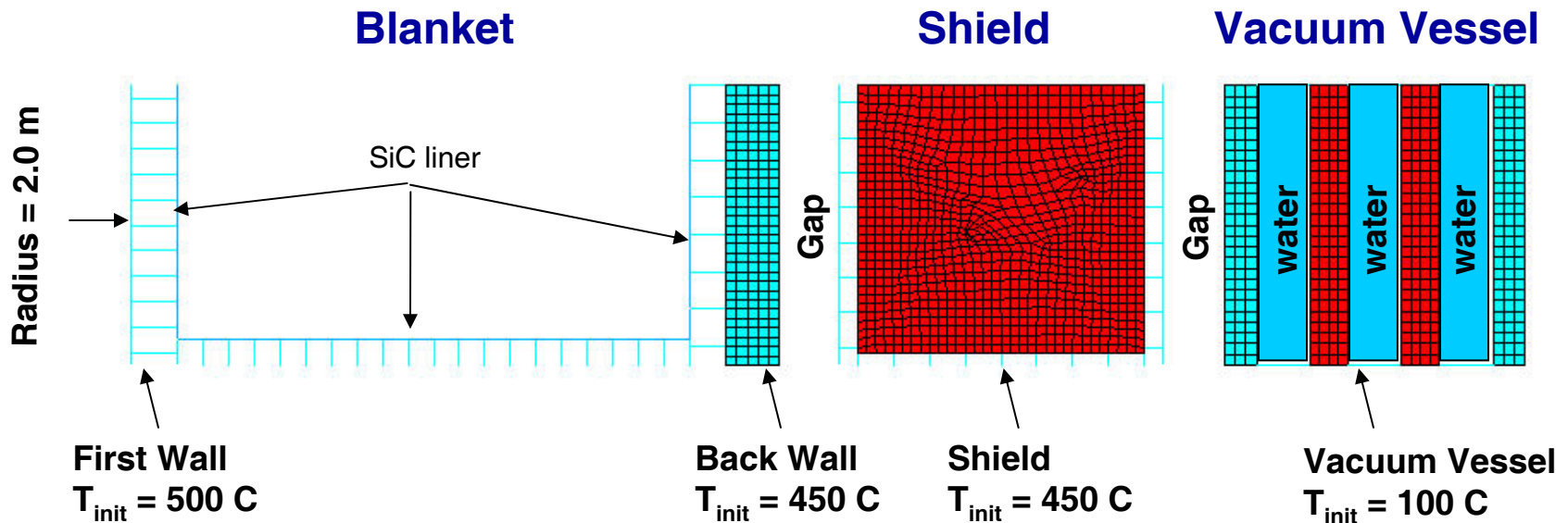
## Short Term Effect of Surface Heating (600 sec.)



# LOCA in Blanket and Shield

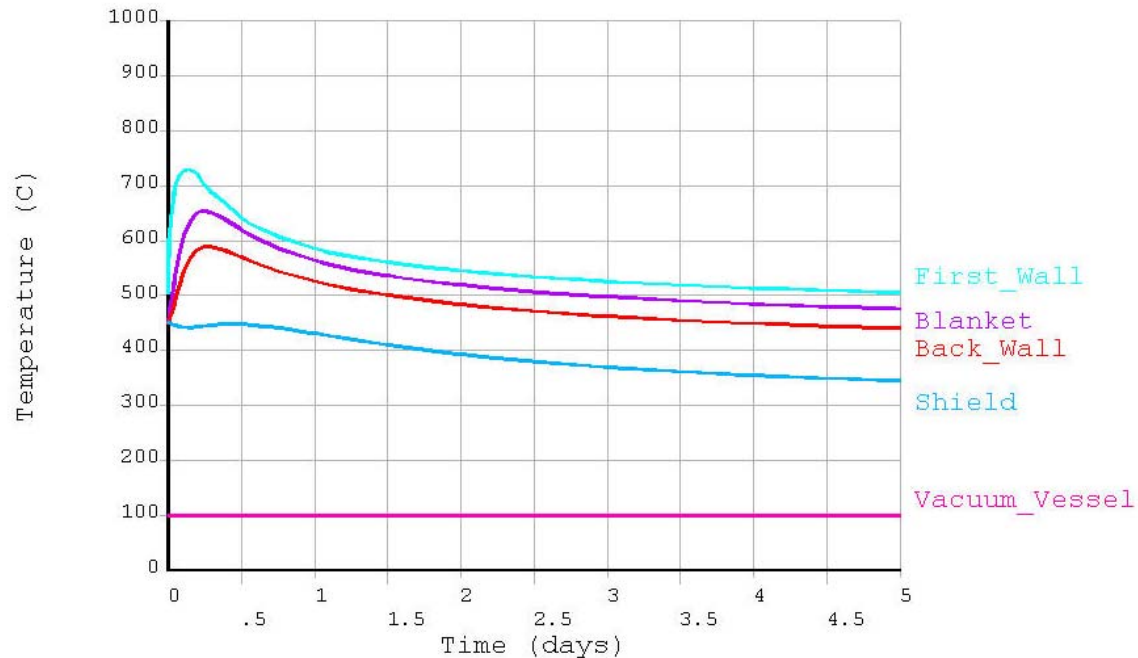
## LOFA in Vacuum Vessel

- Natural convection to water in vacuum vessel assumed
- Heat transfer coefficient of  $500 \text{ W/m}^2\text{-C}$  to  $100 \text{ C}$  water
- Surface and nuclear heating continues for three seconds



# Thermal Response for LOCA in Blanket/Shield and LOFA in Vacuum Vessel

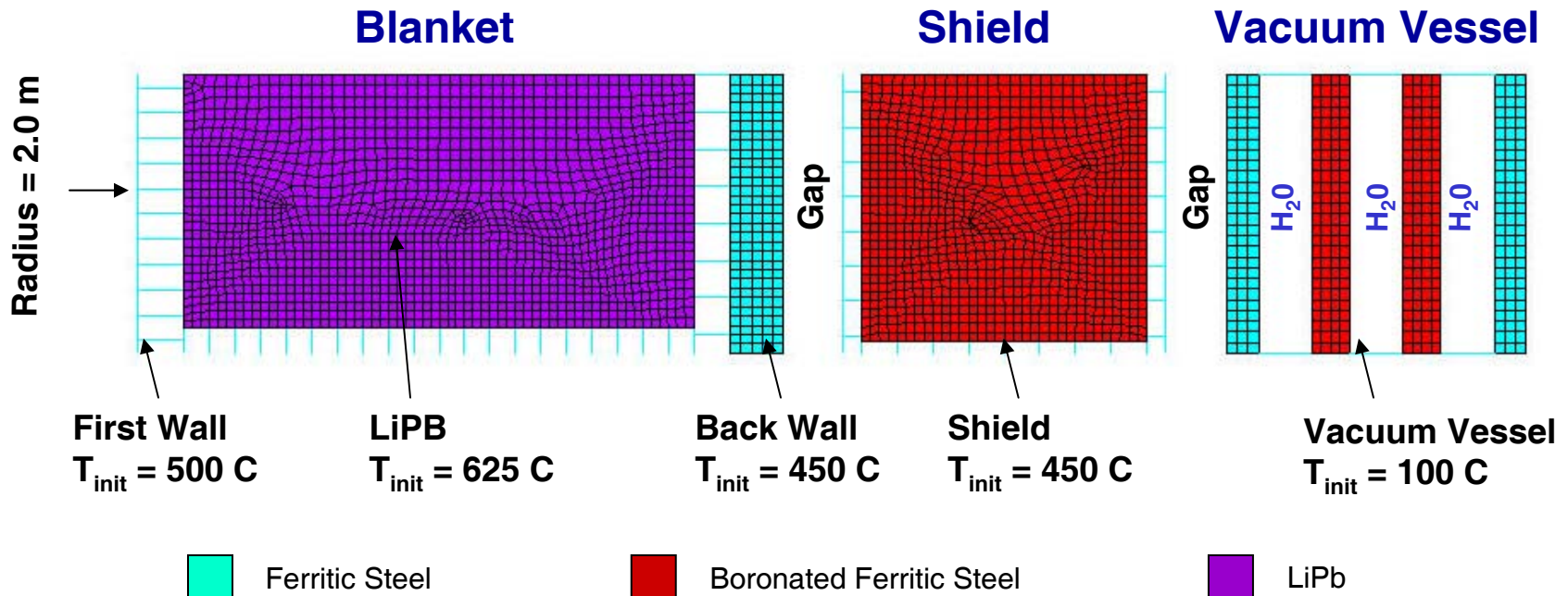
- Peak temperature of 730 C occurs 3.6 hr after loss off coolant / flow and continues to drop with time.
- Addition of surface and nuclear heating increases peak by 2.5 C.
- Results not particularly sensitive to VV convection assumptions.





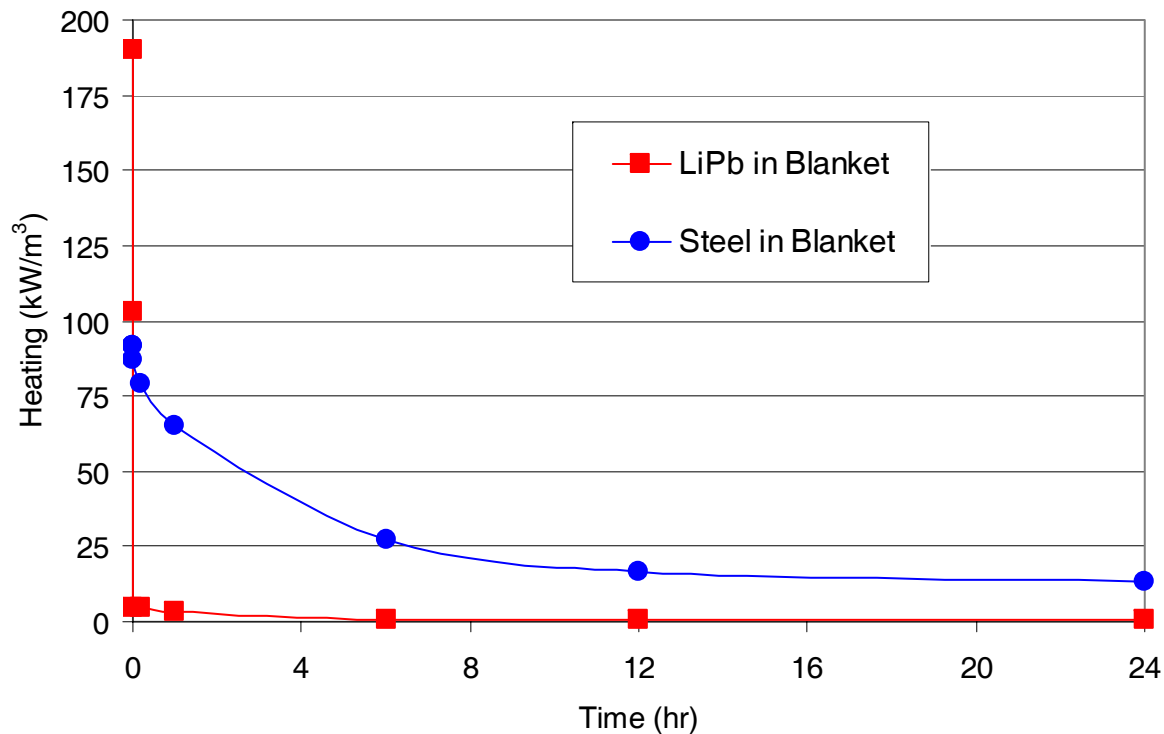
# Analyses Including the Static Presence of LiPb in the Blanket

- Updated estimates of LiPb afterheat included. Heating levels **much lower** than previously assumed.
- Nuclear heating assumed for three seconds after loss of flow.
- Analysis repeating with (LOFA) and without water (LOCA) in vacuum vessel.



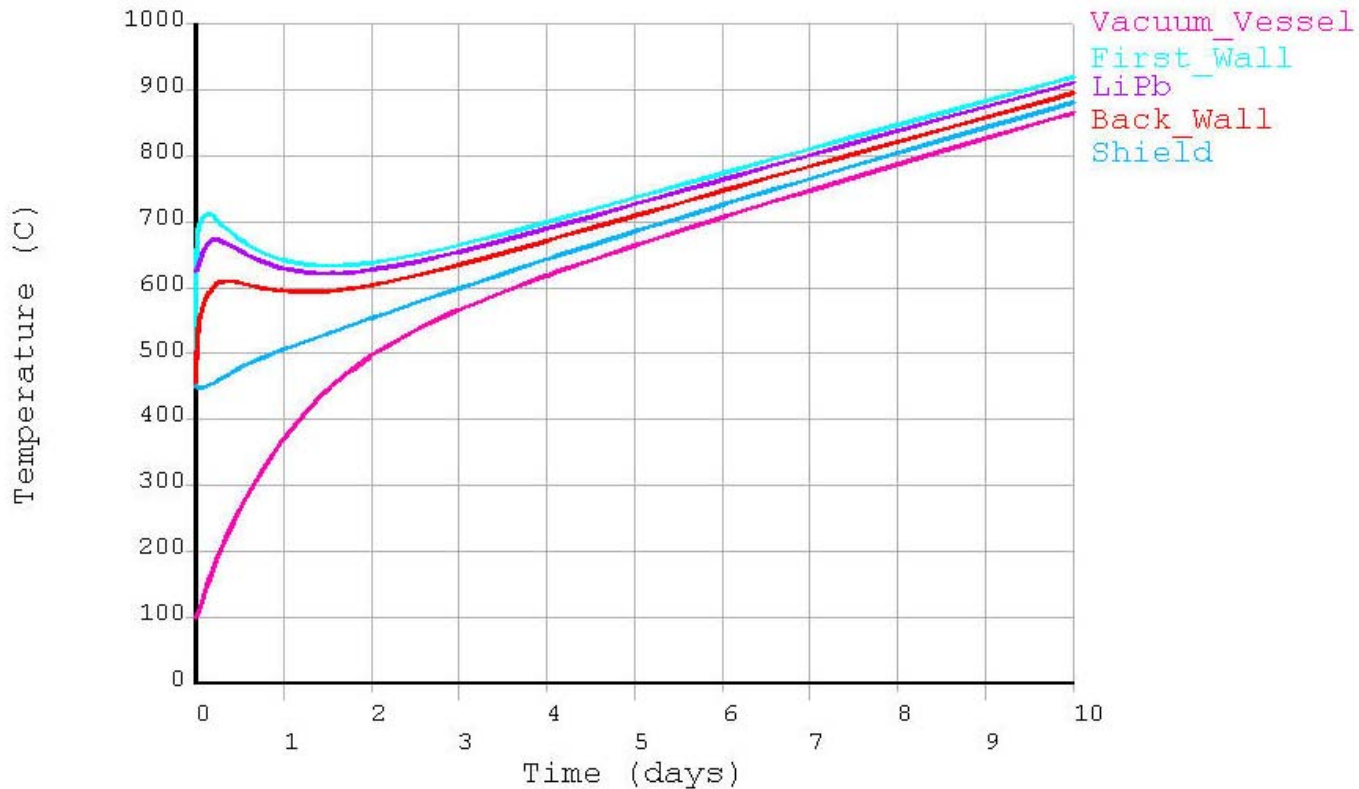
# Afterheat in Blanket Materials

- LiPb afterheat scaled from ARIES-AT data.
- Previously presented results (Sept.) had used heating for steel.



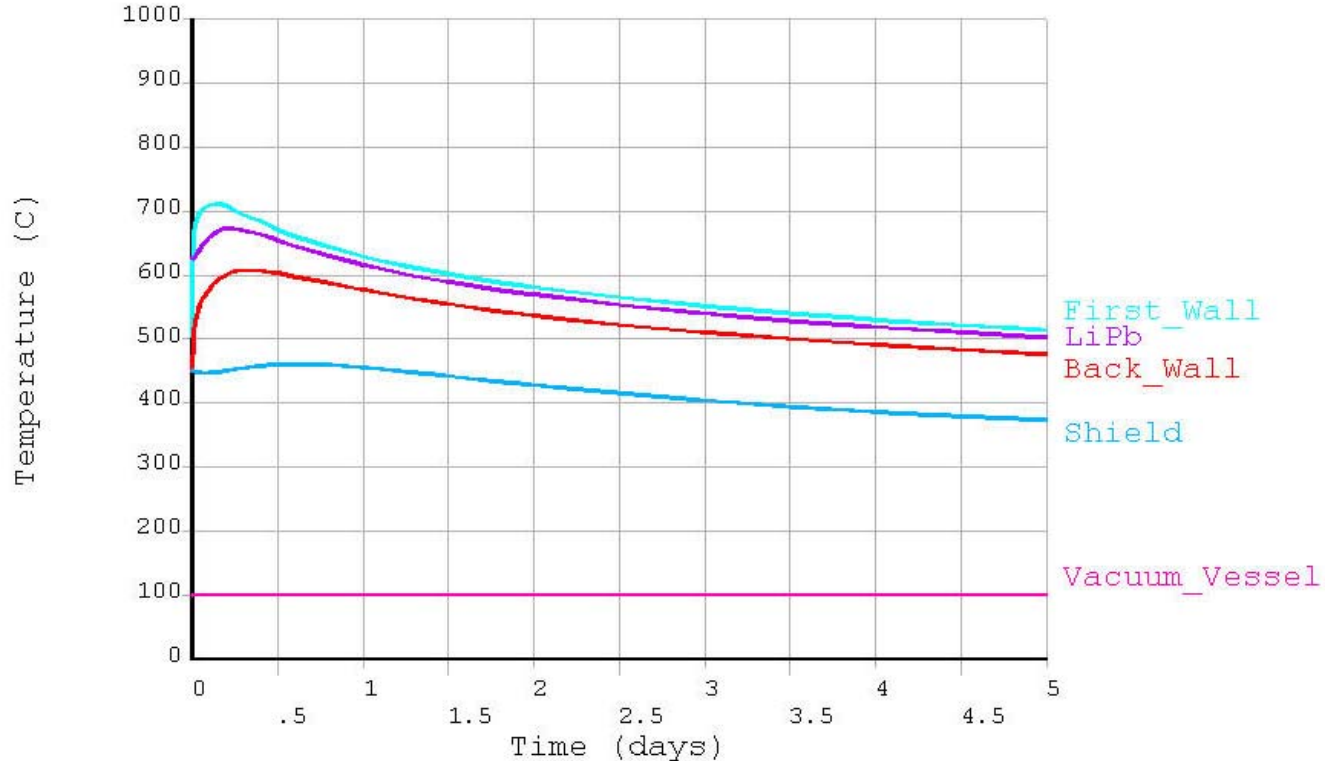
# Thermal Results LOFA for LiPb and LOCA for He and Water

- Resulting temperatures slightly lower than complete LOCA.



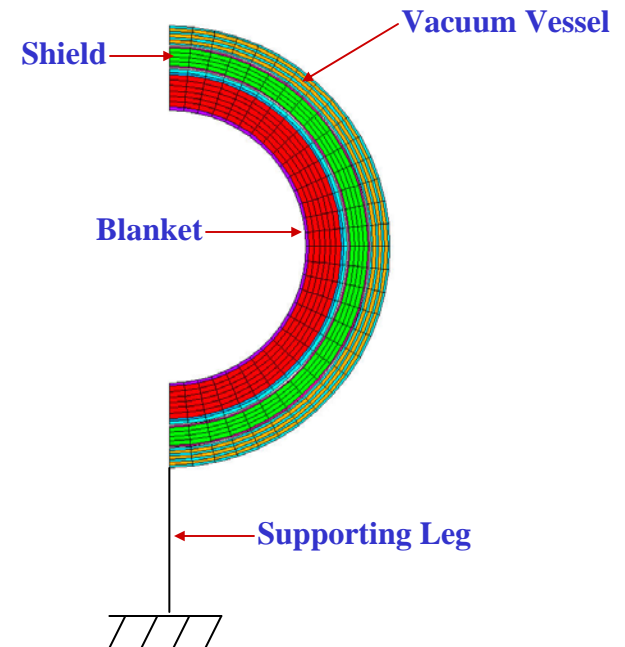
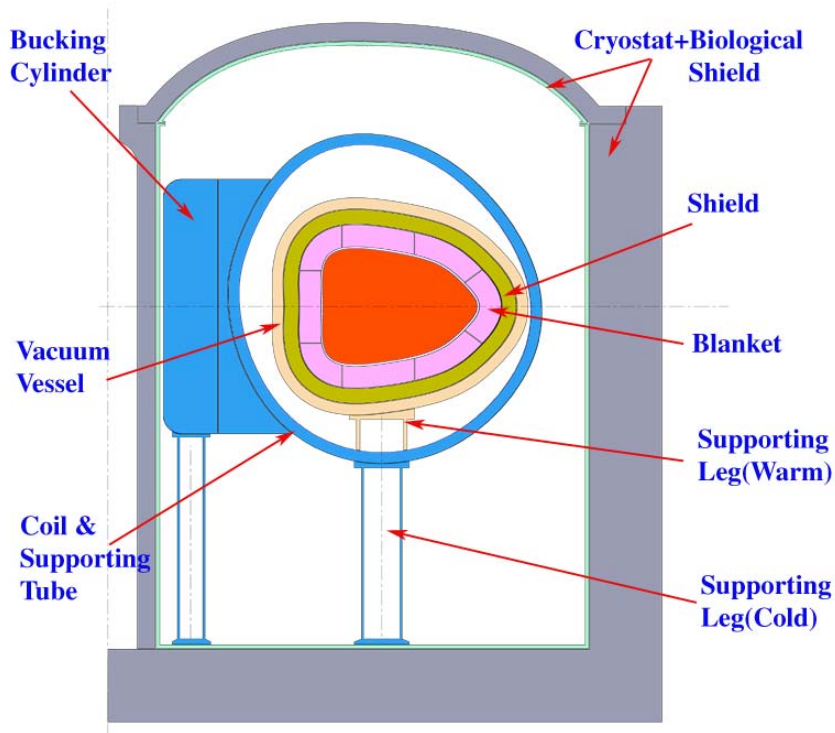
# Thermal Results LOFA for LiPb and Water and LOCA for He

- Maximum temperature 17.8 C less than the case without LiPb.



# Support Structure Modeling

- Model to include heat loss through supporting leg and also structures in vacuum gaps.
- Potential to model noncircular cross-sections.
- Heat transfer from vacuum vessel to coils may also be included.



# Summary

- Peak temperatures are below 730 C for cases with LOFA in the vacuum vessel. Results not particularly sensitive to VV convection assumptions.
- Without heat removal (LOCA in VV), the temperatures continue to rise over time.
- The addition of surface and nuclear heating for three seconds after LOCA increased the peak temperature by 2.5 C.
- Models are being developed to include support structure and heat loss from vacuum vessel.