

# Design and Testing of a New Cooling System using Solid Nitrogen for Pulsed Field Magnetization and Characterization of HTS Bulks

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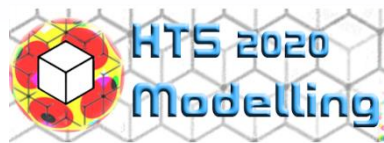
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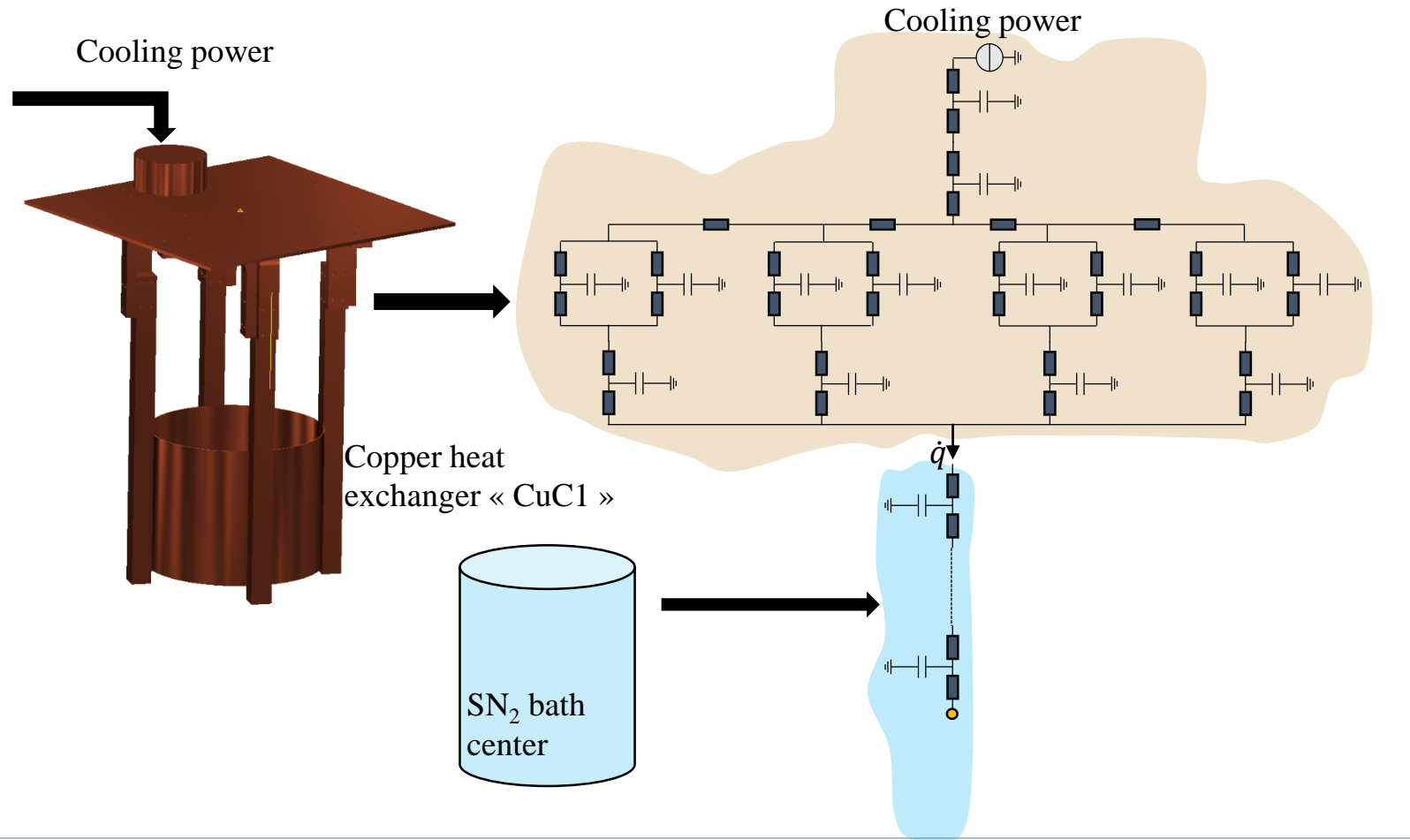
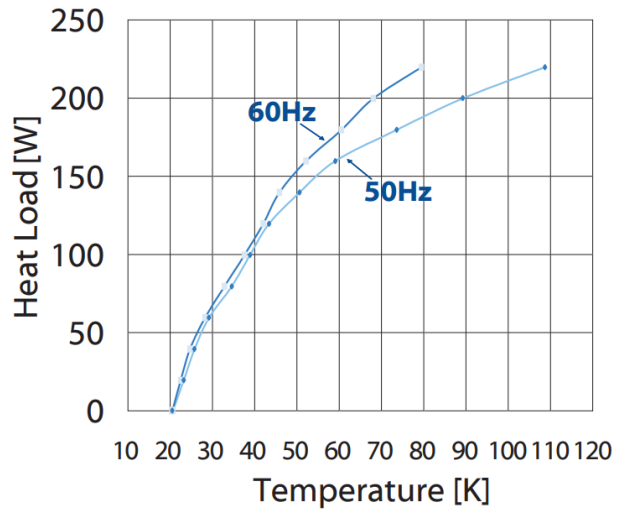
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# Nodal method



# Heat capacity formulation

The heat diffusion equation :

$$\rho C_p \frac{dT}{dt} = P_v + \text{div}(k \cdot \overrightarrow{\text{grad}}T)$$

The thermal conductivity  $k$  :

$$k = \theta_1 k_{\text{ph1}} + \theta_2 k_{\text{ph2}}$$

The specific enthalpy  $H$  :

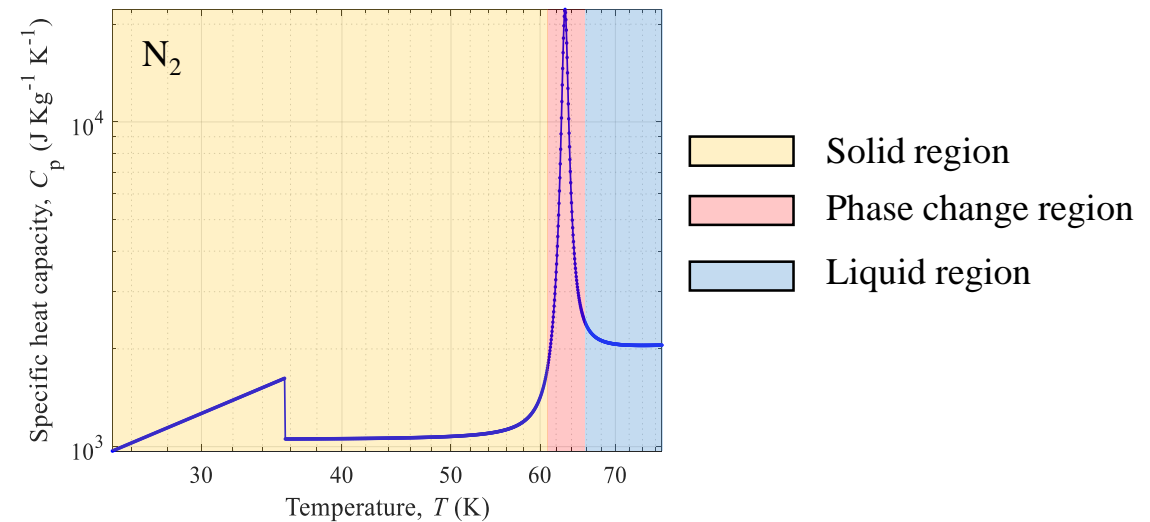
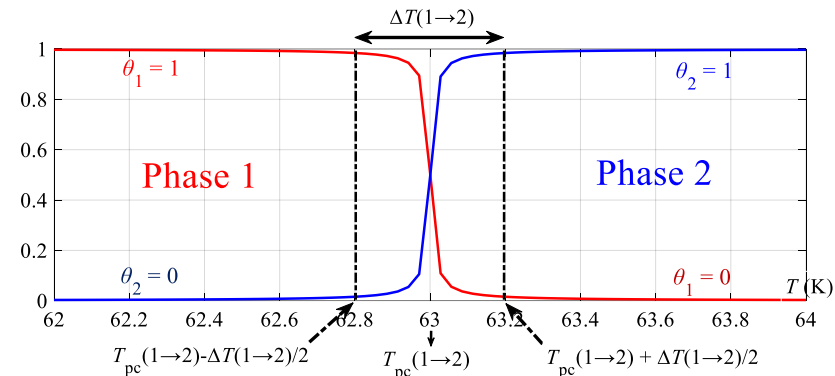
$$H = \theta H_{\text{ph1}} + (1 - \theta) H_{\text{ph2}}$$

The specific heat capacity  $C_p$  :

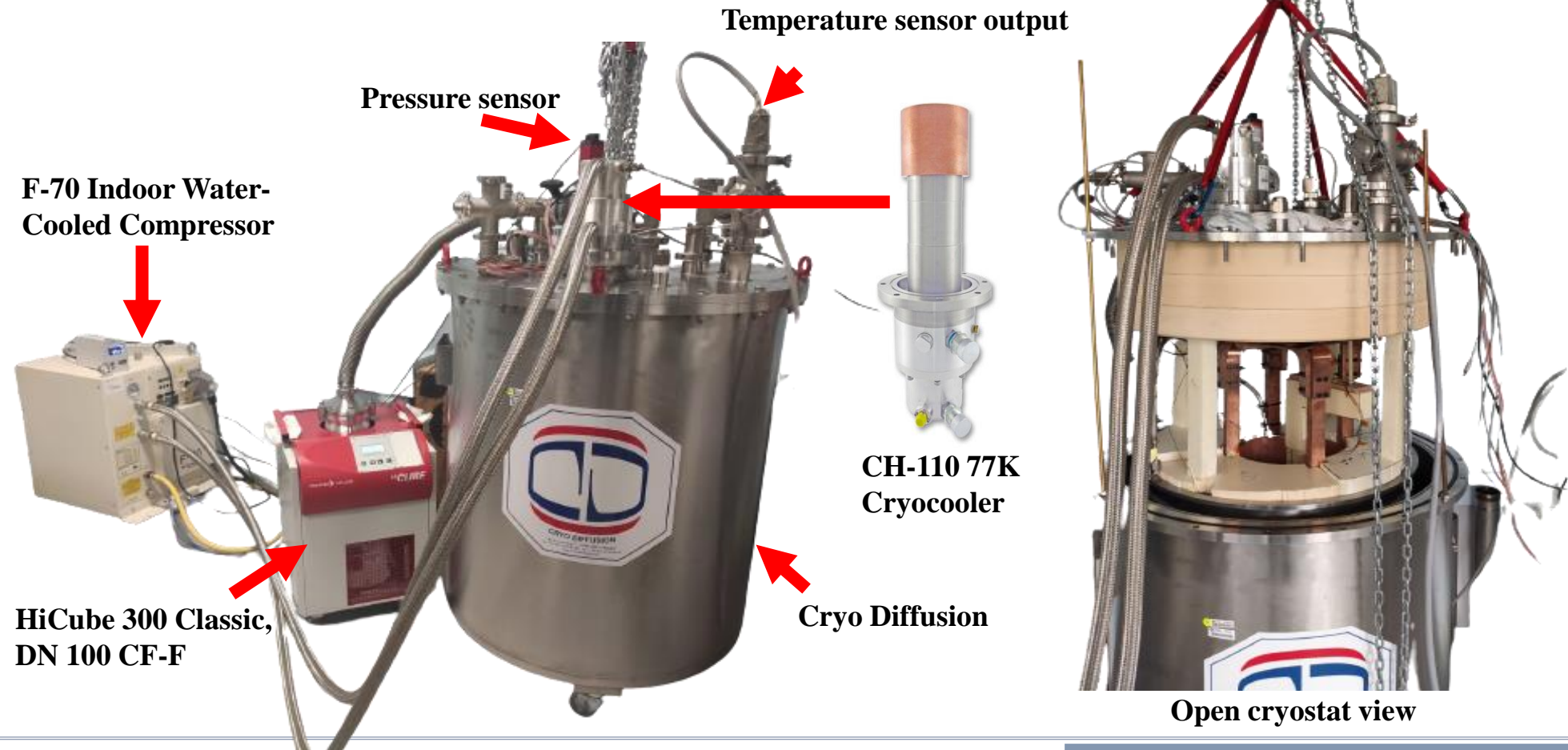
$$C_p = (\theta_1 C_{p, \text{ph1}} + \theta_2 C_{p, \text{ph2}}) + (H_{\text{ph2}} - H_{\text{ph1}}) \frac{d\beta_m}{dT}$$

The Dirac pulse :

$$\beta_m = \frac{1}{2}(\theta_2 - \theta_1)$$



# Cooling systems

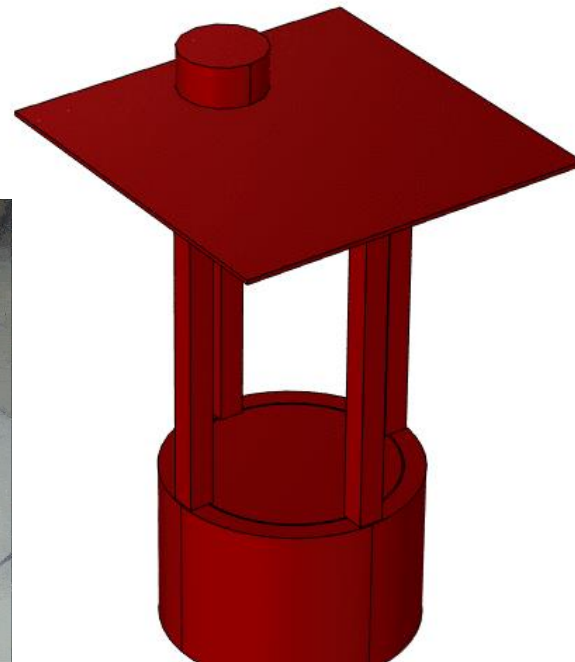


# Results

- ✓ Phase change at a temperature of 63.1 K and a constant pressure of 0.1253 bar.
- ✓ Cooling temperatures e, 77 K to 25 K is about 45 h for 10 liter of liquid nitrogen.

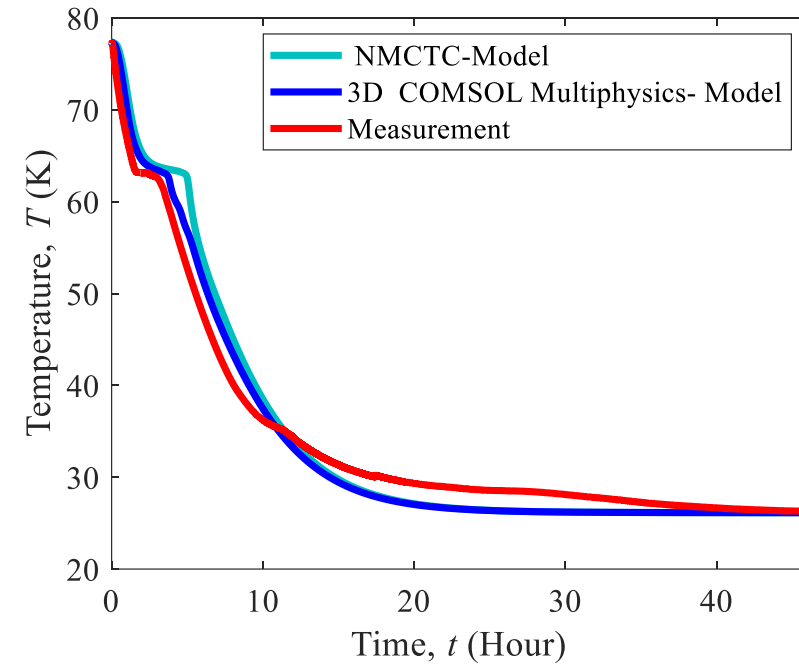
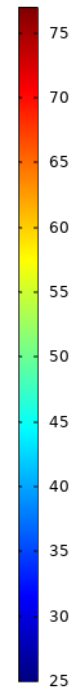


Reality



3D simulation

$T$  (K)



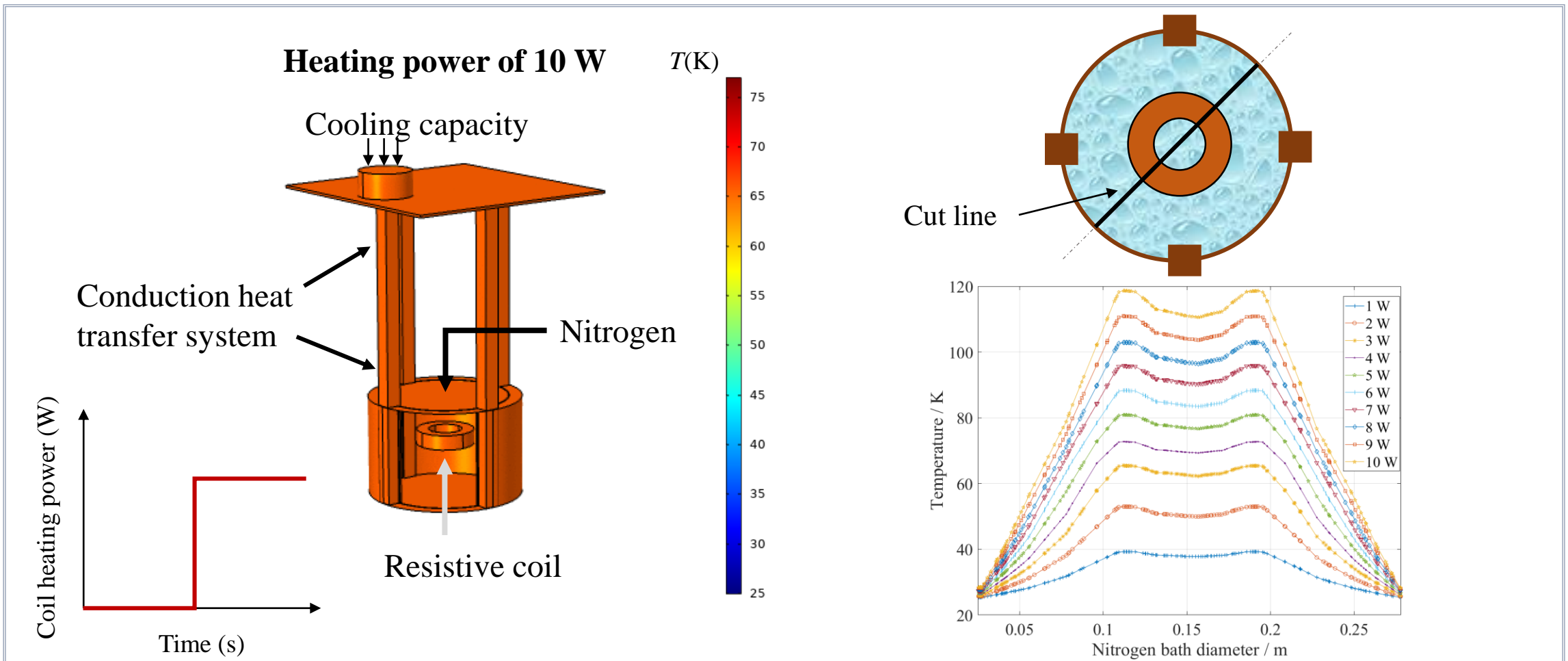
# Conclusion



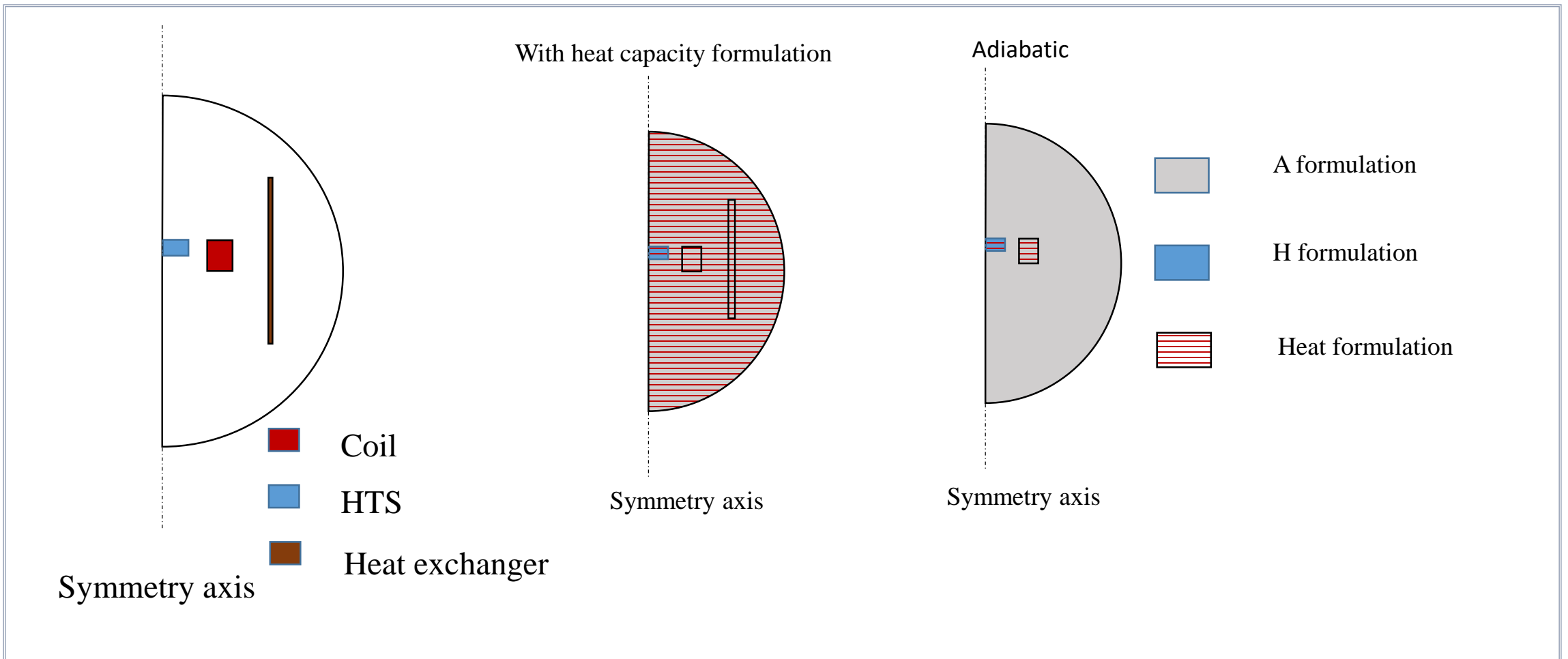
- ✓ The analytical model based on a nodal method coupled with a heat capacity formulation and the 3D simulation in COMSOL were validated with experimental measurements.
- ✓ Pulsed field magnetization tests and characterization of HTS bulbs are planned soon.



# Perpetive PFM study

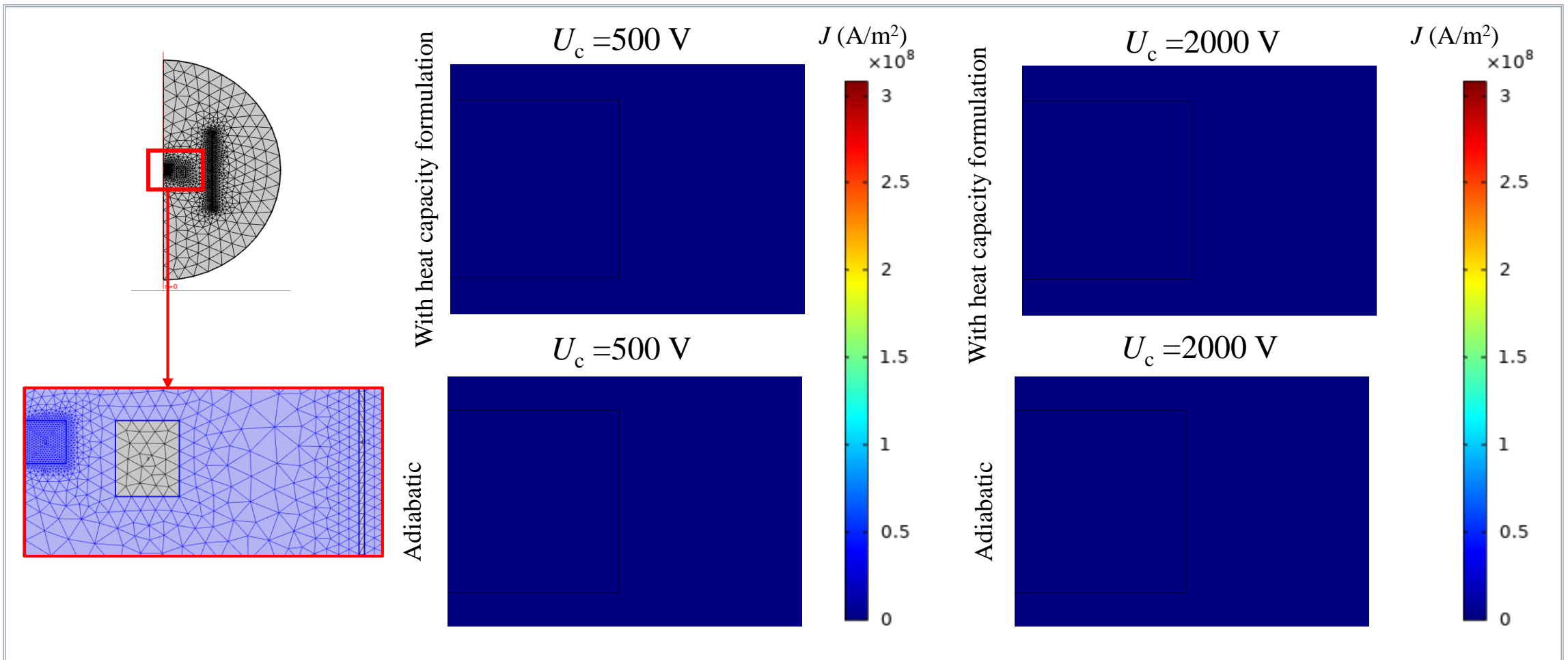


# Perpetive PFM study

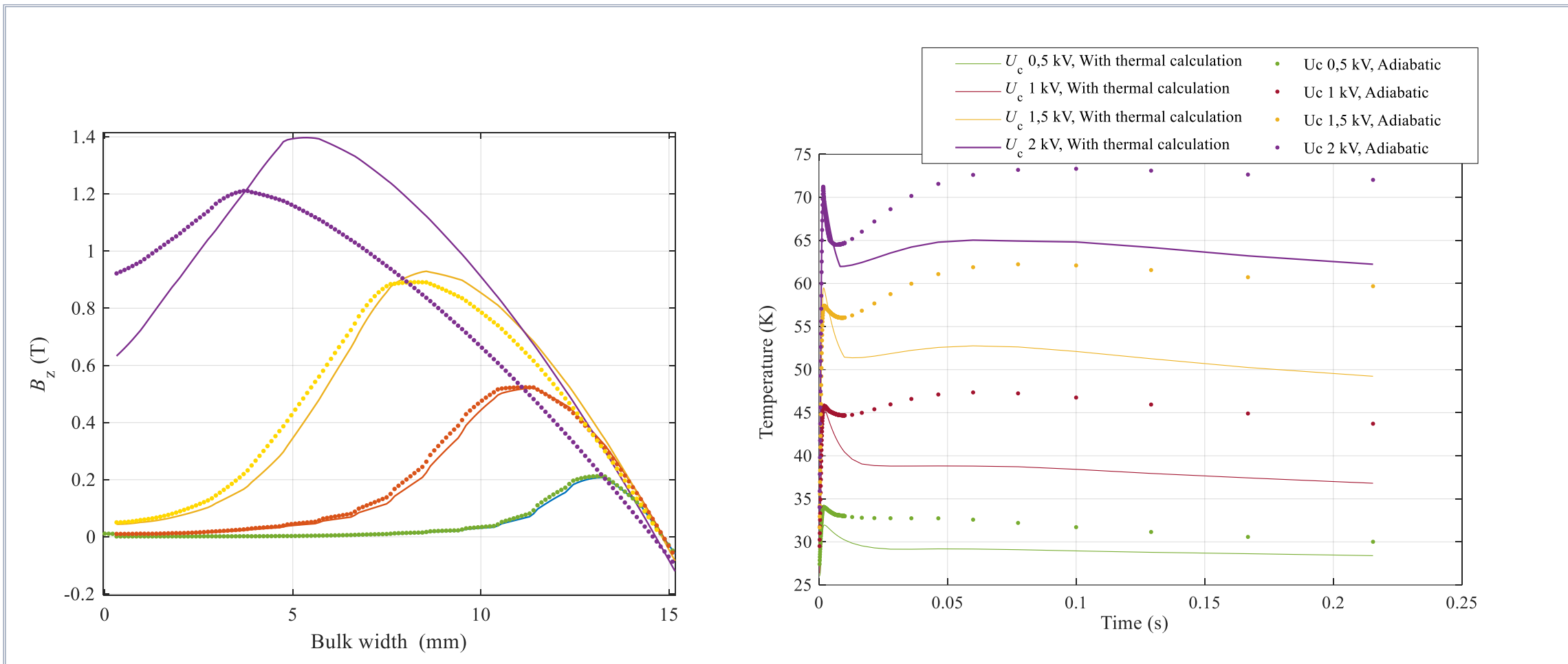




# Perpetive PFM study



# Perpetive PFM study



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# Thank you for your attention

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