Possible Relationship Between Defect Pre-Heating and Defect Size

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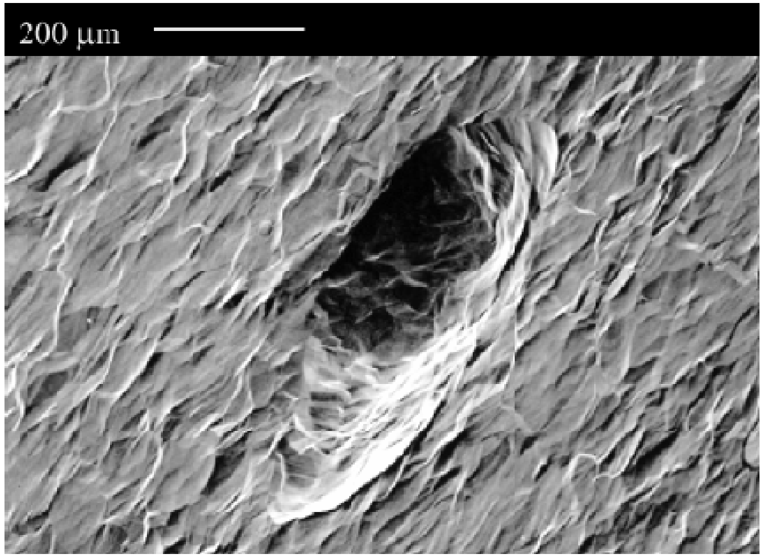
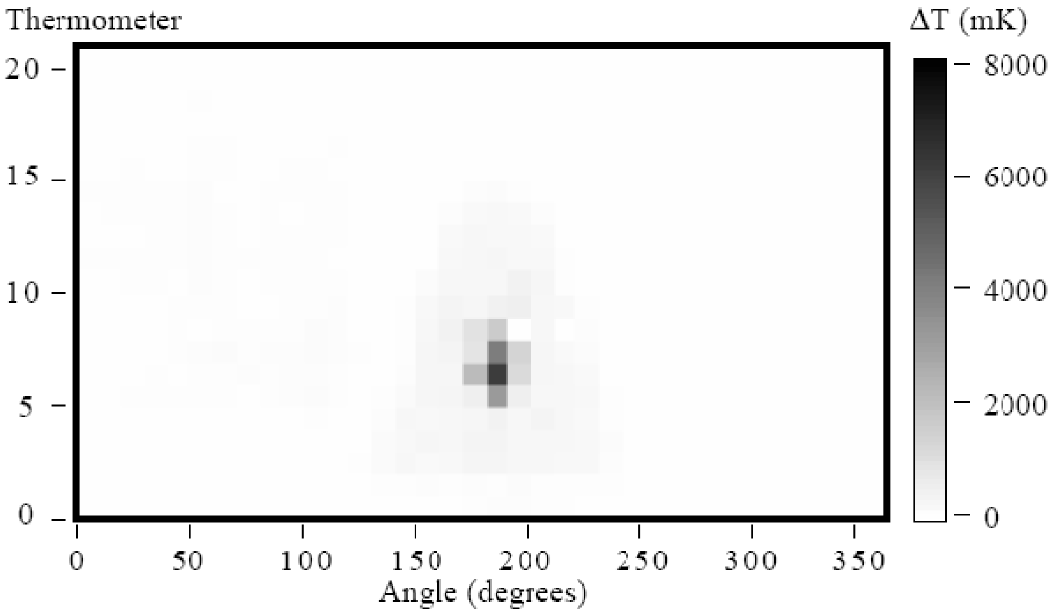
- S0 Meeting, Jan 26, 2009

High Resolution SEM Image of Quench Causing Pit
From J. Knobloch Thesis (1997)





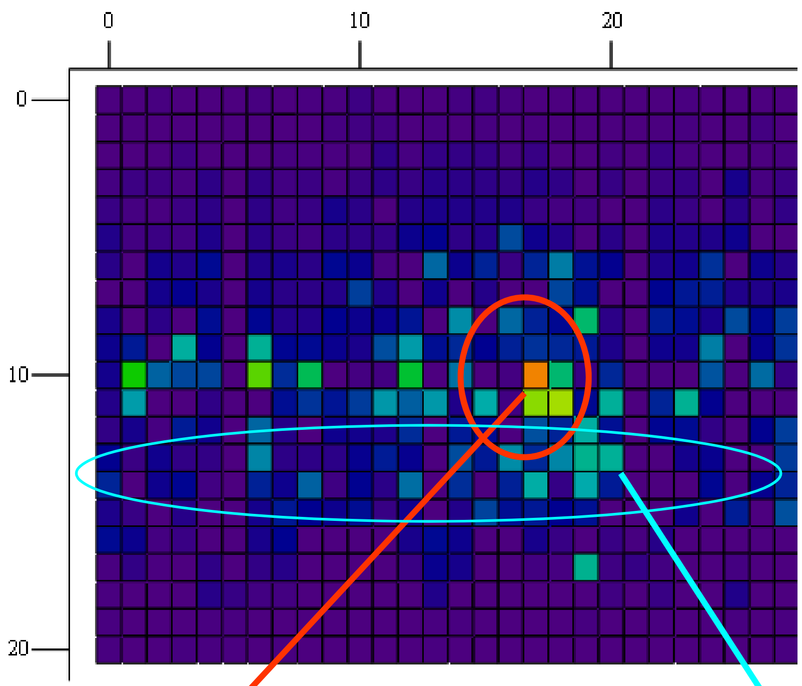
- Quench detected in single cell 1500 MHz cavity at 93 mT (22 MV/m)
- Cavity prepared by BCP
- Pre-heating at same field just below quench was 300 mK
- Pit with sharp edge found at defect site after cavity dissection
- No foreign elements found with EDX

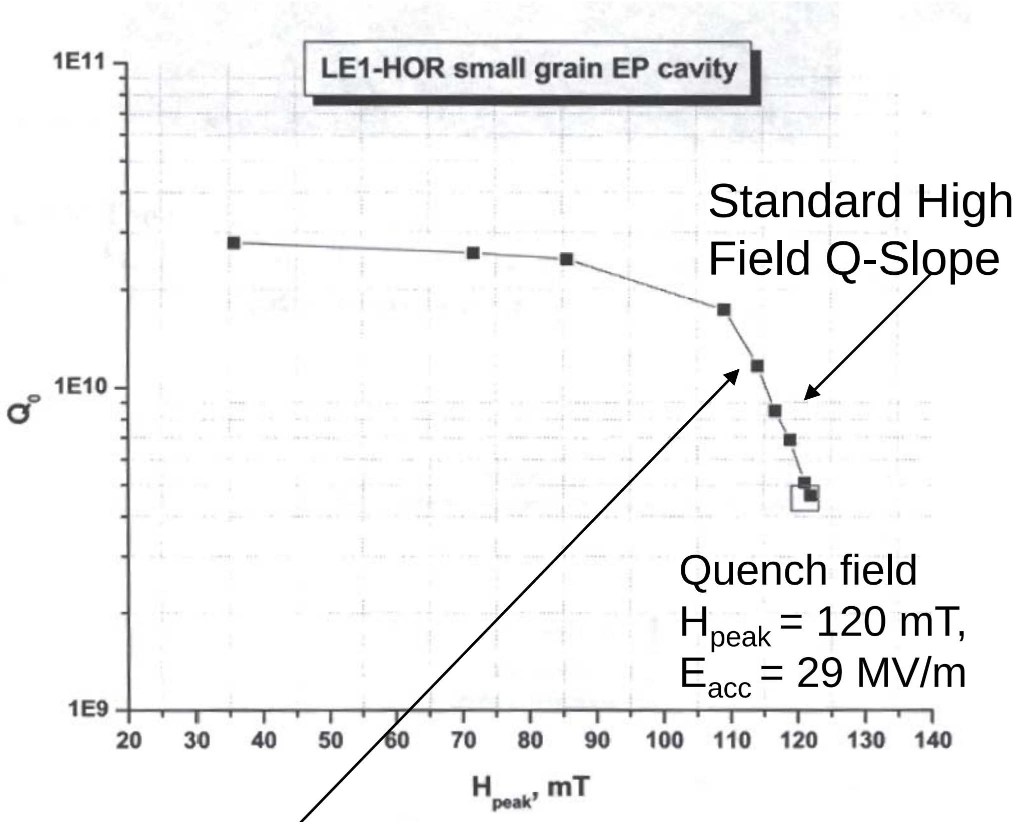
Another Pit Defect Found in Single Cell 1500 MHz

From 2008 Thesis by A. Romanenko

- Reported at Chicago ILC-2008 Meeting
- Cavity prepared by EP and flash BCP, No bake
- Quench at 120 mT (~29 MV/m)
- Extract samples to study high field Q-slope and Quench

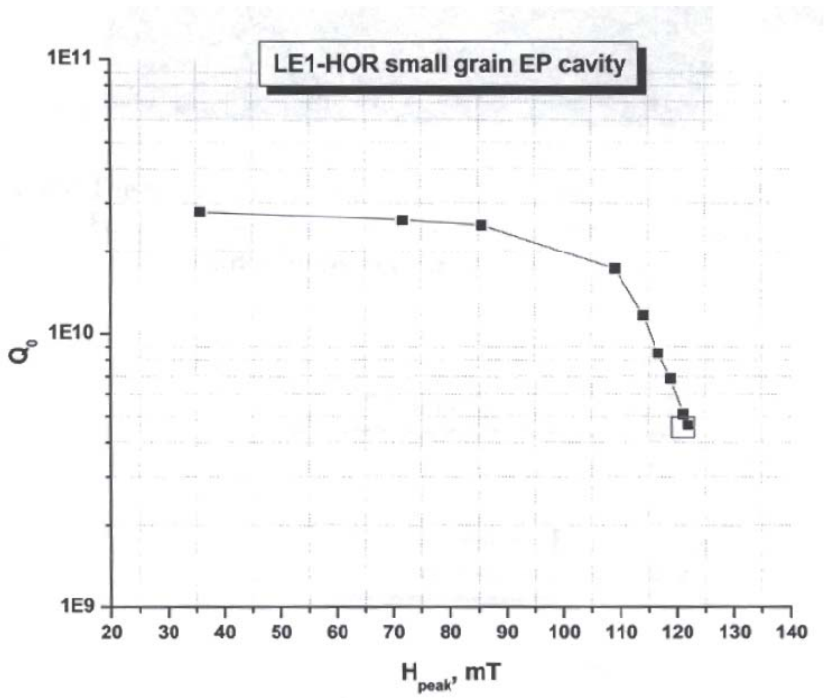
Temperature Map at 120 mT & Q vs E

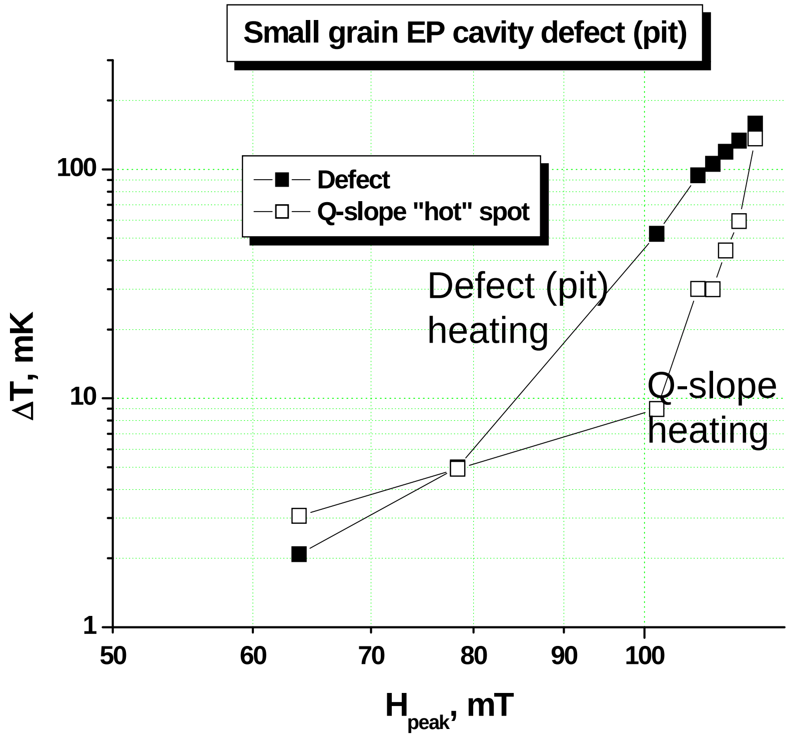




- General heating due to high field Q-slope
- Defect heating at quench site at field BELOW quench

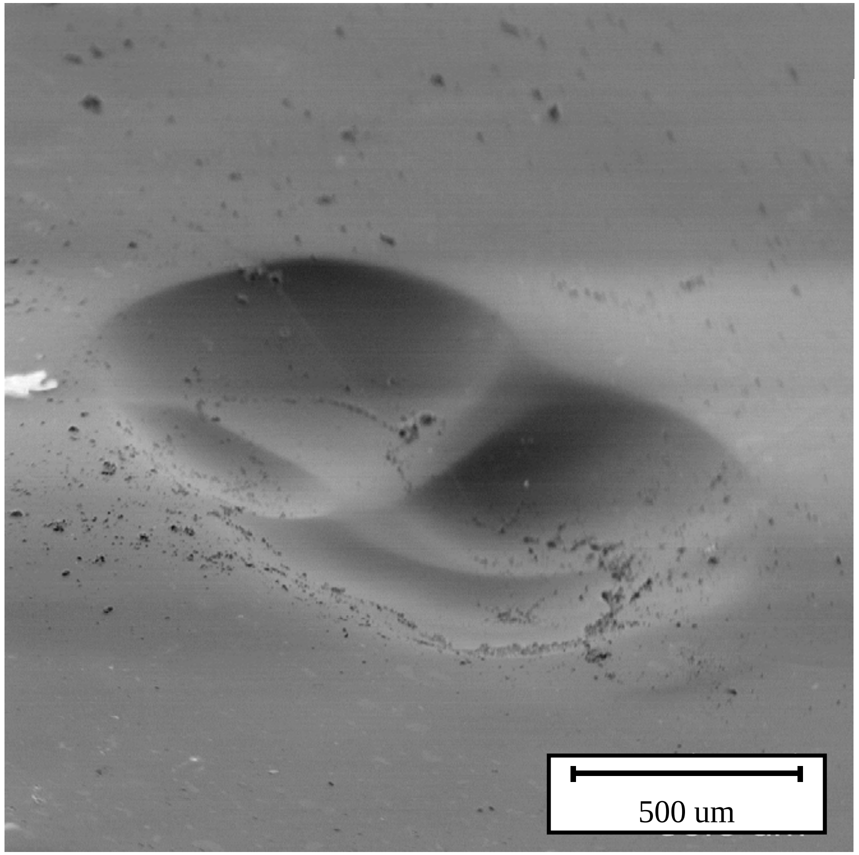
Response of Individual Thermometers



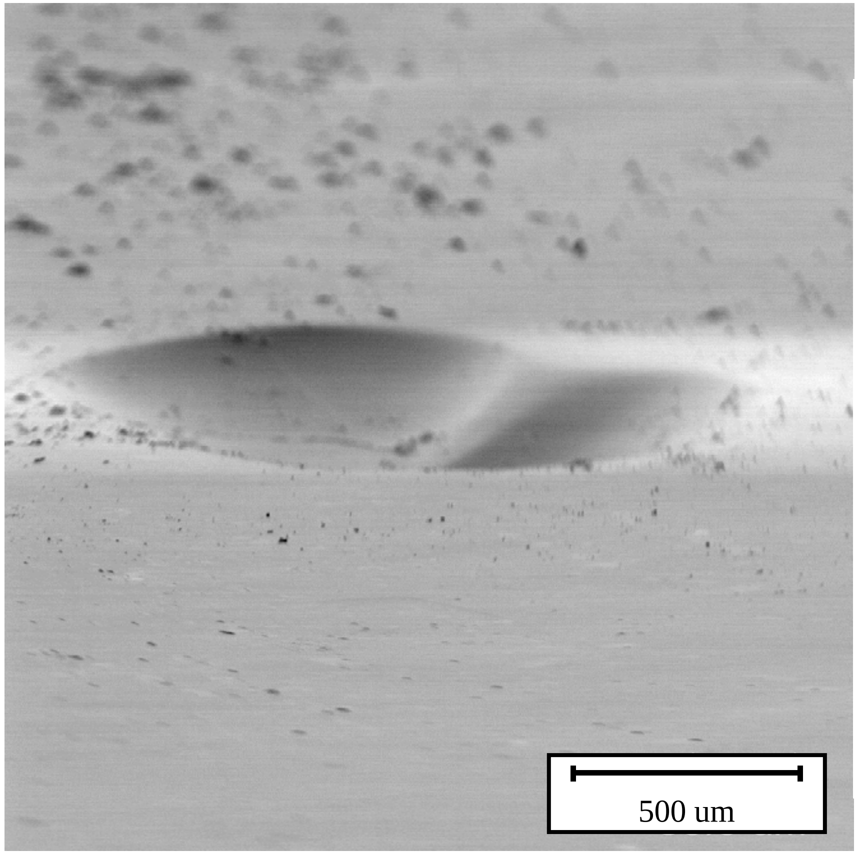


- Defect heating surpasses Q-slope heating above 80 mT
- Defect heating dominates strong Q-slope heating until about 110 mT
- Maximum thermometer signal due to defect heating alone is 180 mK
  - closer to 100 mK if we subtract Q-slope heating (which we do not know exactly)
- Use 100 – 180 mK for defect heating range (remember this !)

SEM on Extracted SampleReveals Large Pit

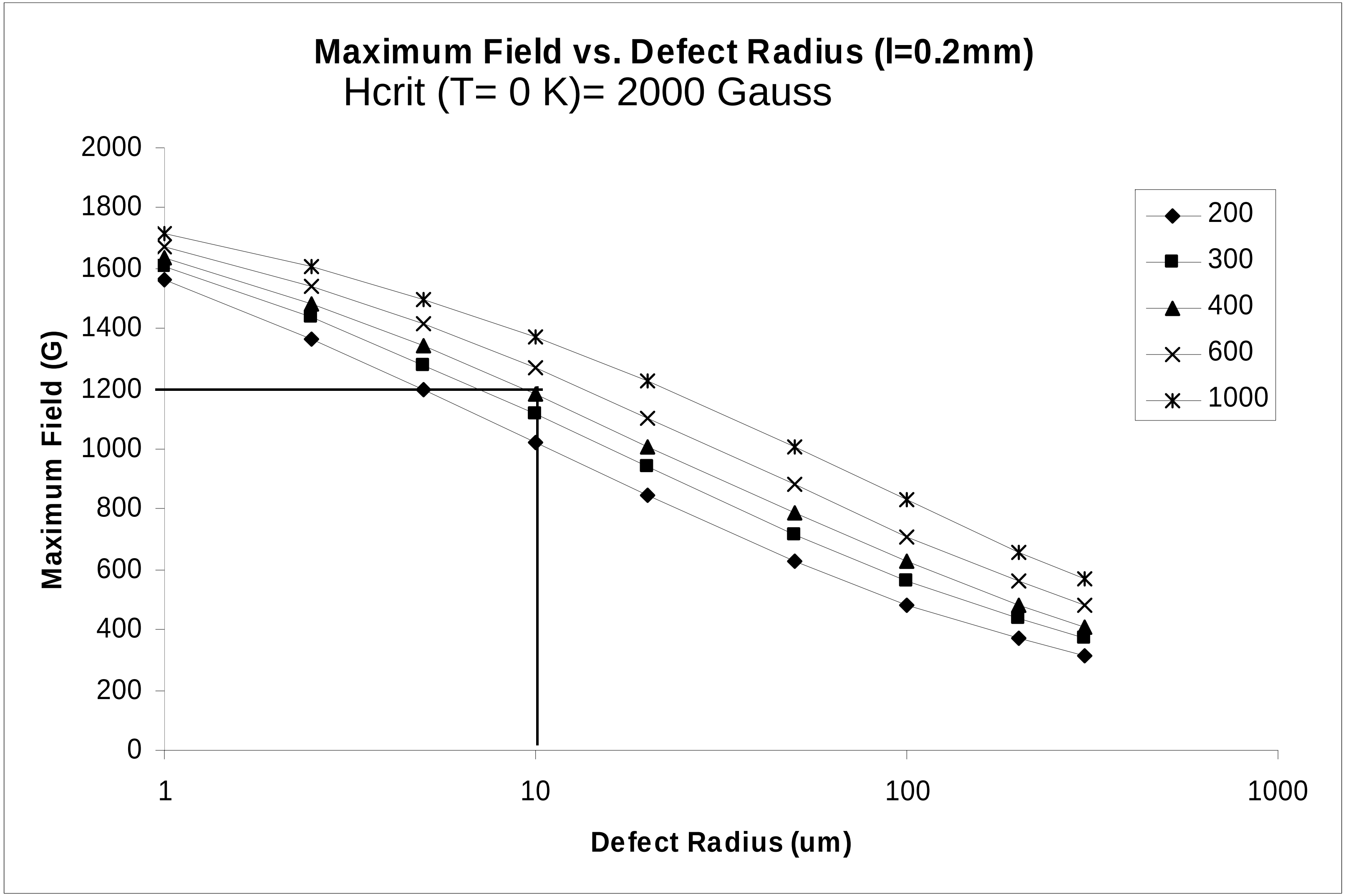


SEM back-scattered image



SEM

- Problem: Thermal model predicts that normal conducting defect size (e.g 20μm diameter) to cause quench at 120 mT should be <u>much smaller</u> than observed pit size (mm) Wiener et al, TTC-note 2008-8.



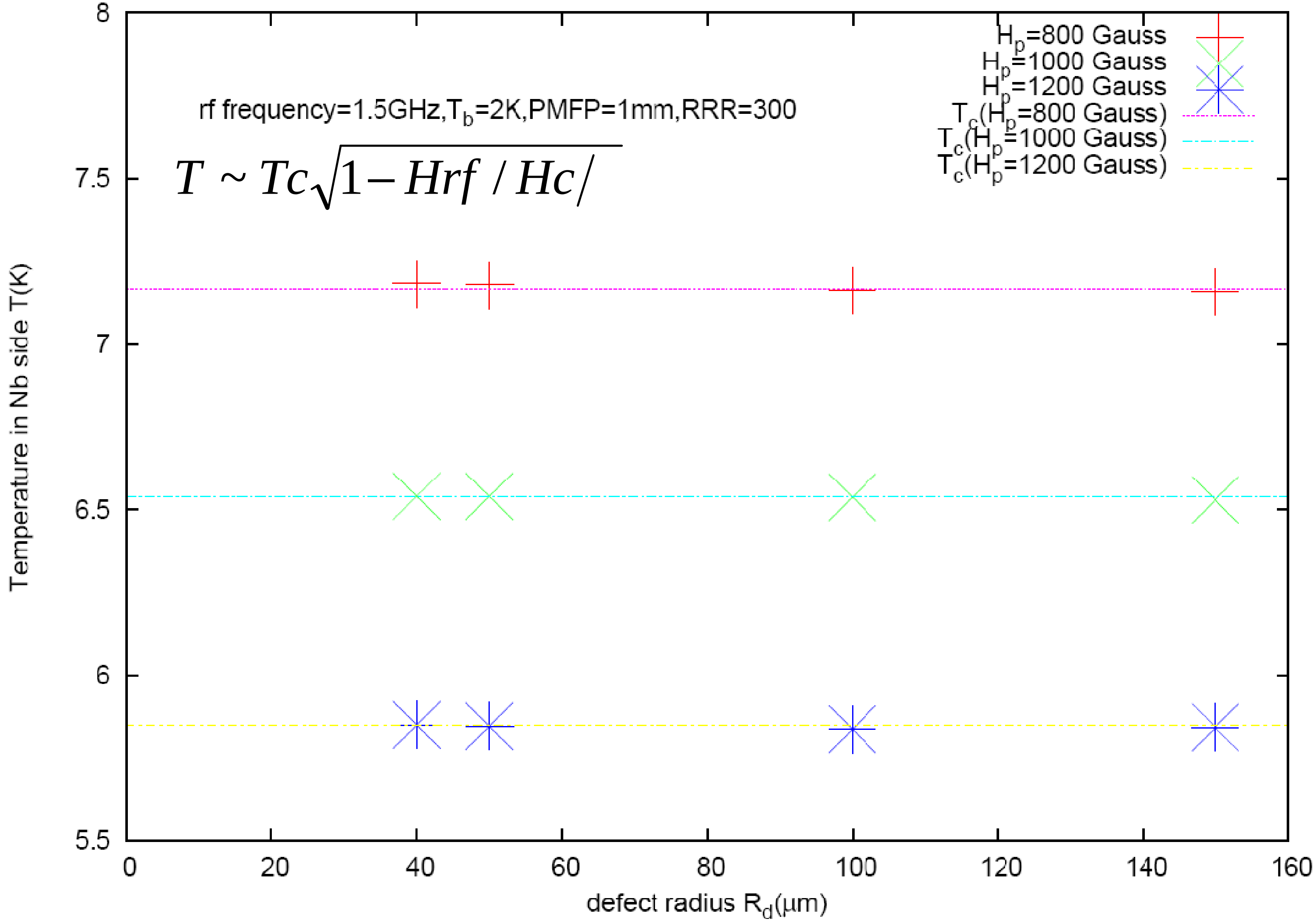
Can Pre-Heating (Temperature Map) at the Defect Site Tell Us More About the Actual Size/Resistance of the Quench Producing Region?

- The thermal model assumes a “normal conducting” defect and adjusts the radius to reach a specified quench field.
- But the observed pit is much larger than the model predicts
- => either the active defect region is much smaller than the observed pit,
  - or the effective resistance is much smaller than normal conducting, or some combination
- Thermometry can help to sort this out !

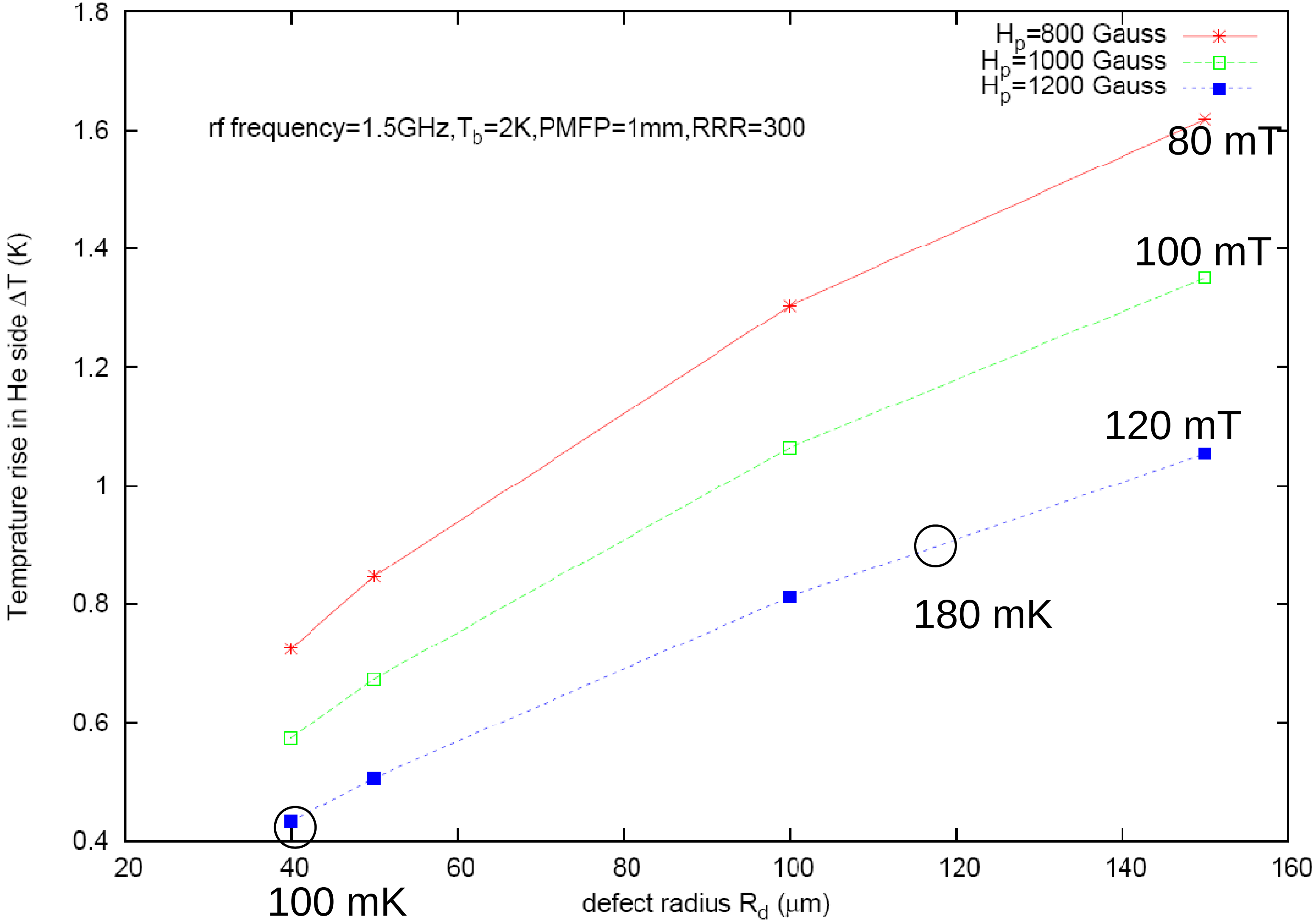
New Calculations

- For a specified quench field vary both the defect size and the “defect” surface resistance to reach quench.
  - Calculate temperature rise on the rf surface just below the quench field
  - The temperature should approach $T_c\ (H)$ just outside the defect
- Calculate the temperature at the outer cavity wall
- Compare observed temperature rise at thermometer with calculated temperature rise at outer wall
- Remember that the thermometer detects only 20 – 25% of the actual temperature rise
  - Previously calibrated (see J. Knobloch thesis)

Calculated Temperature Next to Defect on RF Side Near Quench Field (Yi Xie)

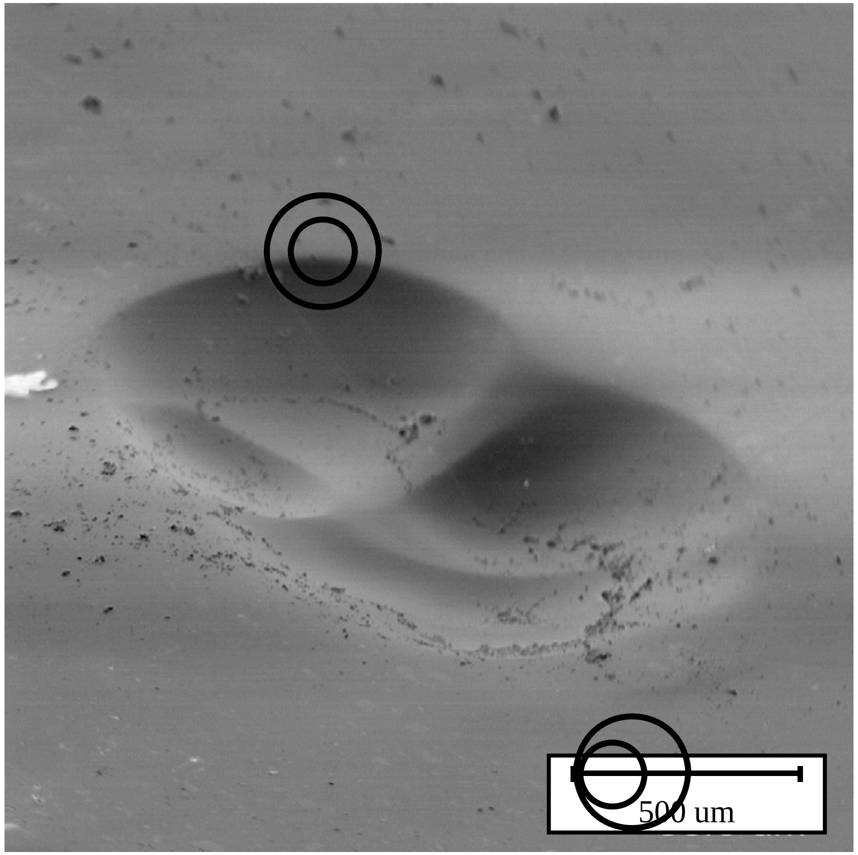


Calculated Temperature Below Defect on Outer Wall Near Quench Field (Yi Xie)

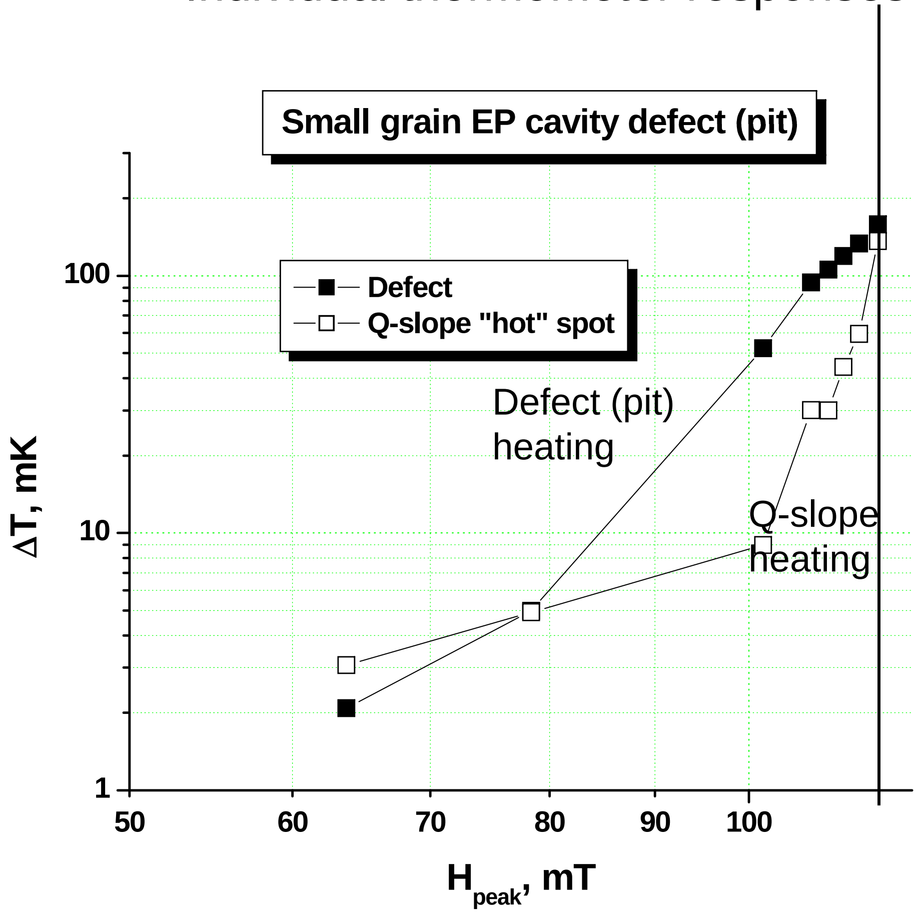


Estimate Size of Resistive Region from ΔT and Calculations

Possible region of high field enhancement and quench



Individual thermometer responses



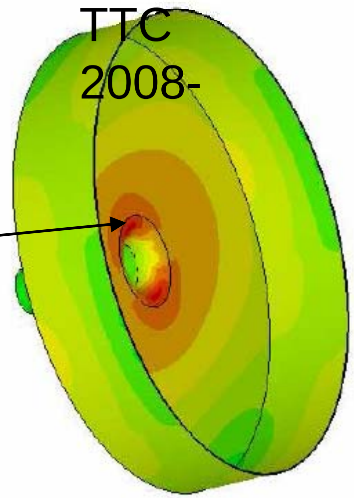
SEM back-scattered image

Conclusion

- Pre-heating of defect provides additional information about the nature of the defect
- Comparing the observed pre-heating of the defect with thermal model calculations suggests that in the case analyzed
- The observed pit is very much larger than the actual region responsible for quench
- Further support for the edge enhancement theory
- Quench takes place at regions of current density enhancement

Shemelin

TTC 2008-



Calculations of Field Enhancement for Pits