Hot Topic #1
High-Field Q - Slope

SRF 2005

Wednesday, July 13,2005

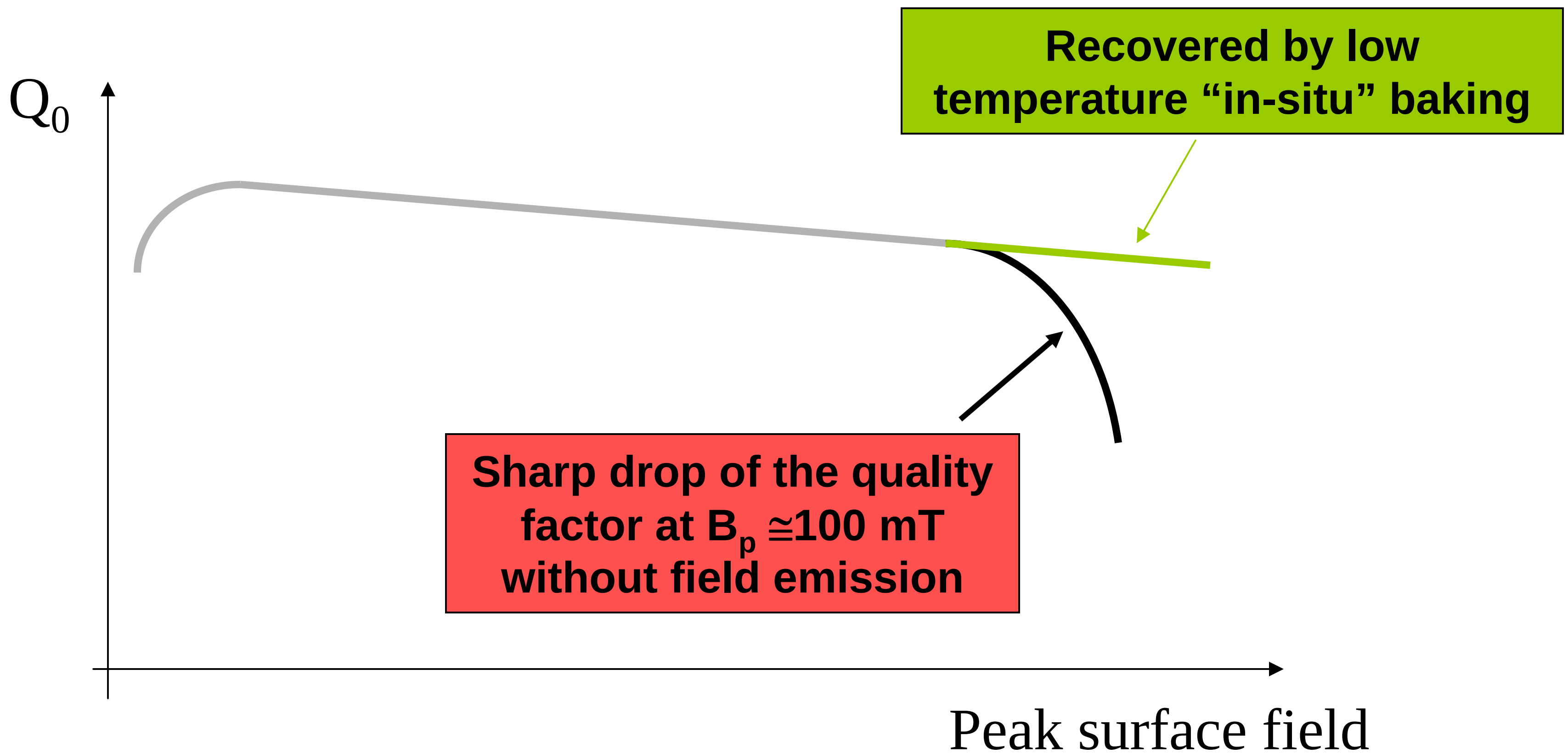
Summary of contributions from previous Day (P. Kneisel)

Observations at Saclay (B. Visentin)	5 min
Q – slope model (P. Bauer, FNAL)	5 min
Observations at DESY (D. Reschke)	5 min
Observations at KEK (K. Saito)	5 min

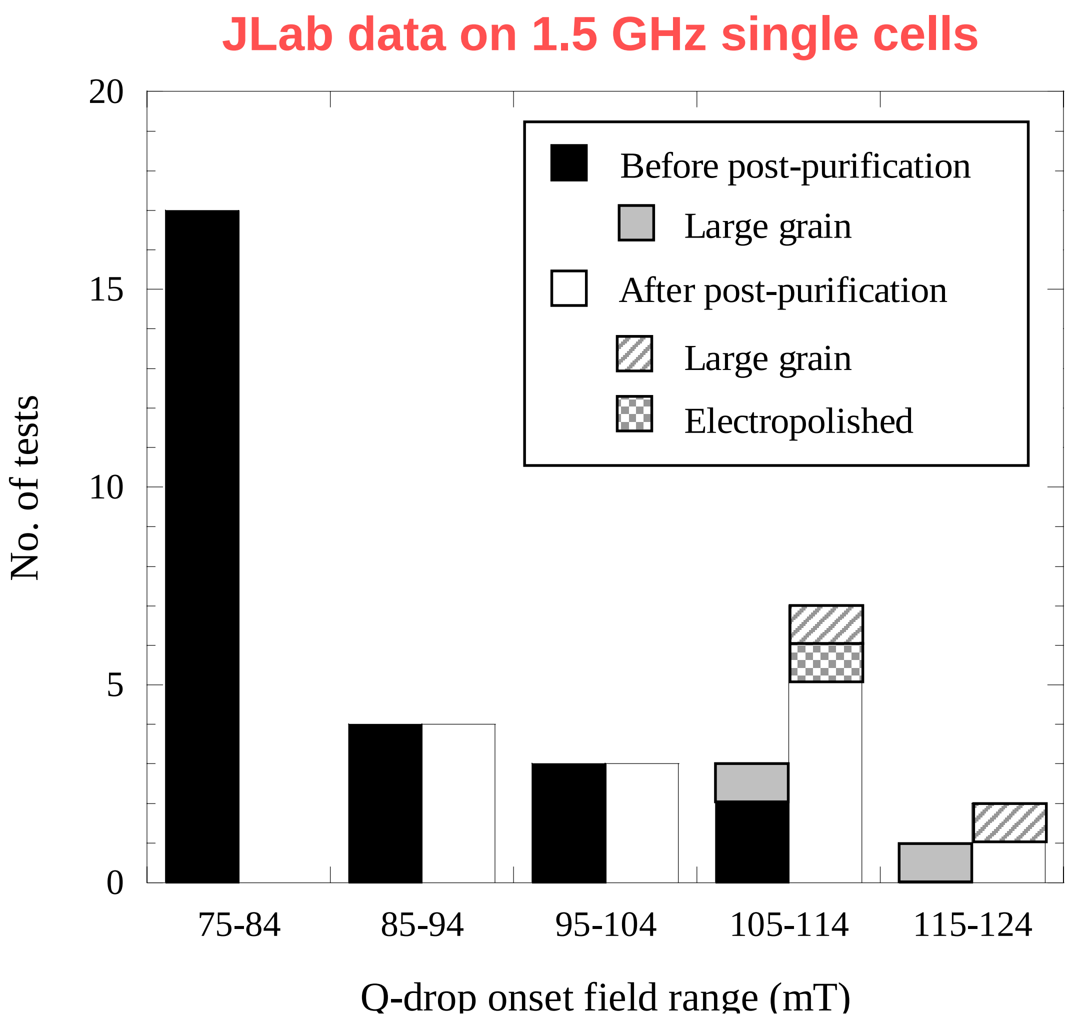
Discussion Items

- Is the high field Q-drop a magnetic or electric field effect?
- What is the impact of grain boundaries on Q-drop?
- Is there a frequency dependence of the onset value for the Q-drop?And if so, why?
- Are there other remedies than "in situ"baking to eliminate the Q-drop?
- Does surface smoothness play an important role in a successful "in situ" baking?
- Is there an optimum baking temperature and time for improving high field Q –values and maintaining the residual resistance?
- Is there a favorite model, which explains all the experimental observations?
- Does hydrogen play a role?
- What additional crucial experiments are necessary to fully understand the Q-drop?

Q-drop: obstacle before the ultimate limit



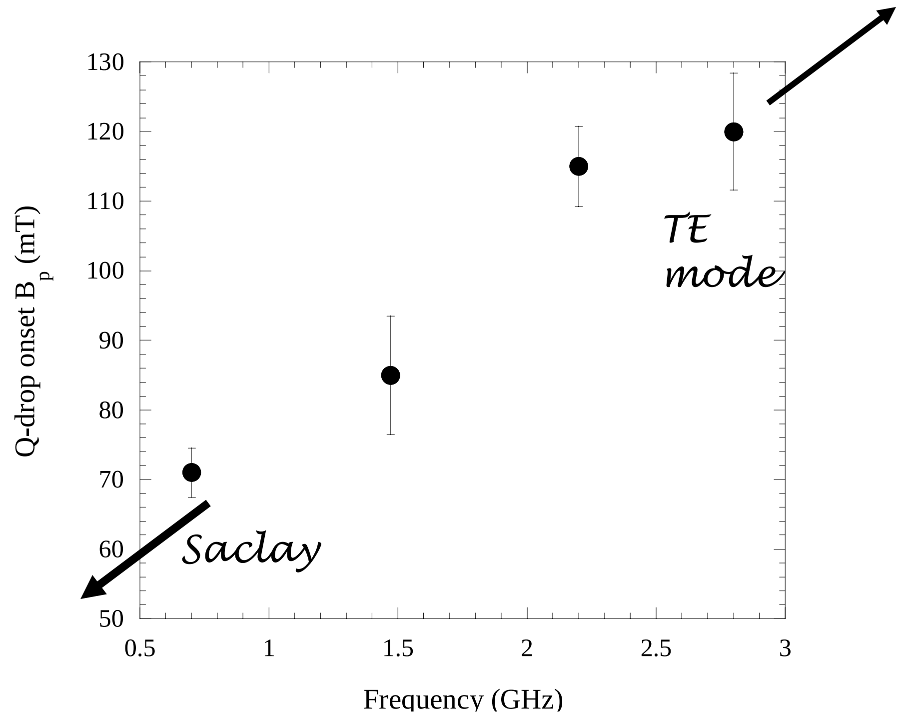
Statistic on Q-drop onset field



BCP,EP,Fine grain,large grain

- Q-drop is common to BCP, EP and Single crystal cavities in high RRR niobium
- The "onset" field increases with increased grain size (reduced # of grain boundaries?)
- The baking effect is different in "fine grain" niobium treated by BCP and EP; it is similar for increased grain size (e.g. after post purification @ T>1250C)
- "Air baking "is less effective than "UHV" baking,but more/newer data available from B.Visentin

Q-drop onset freq. dependence



- No "Q-drop" observed in X-band cavities in the "old days": f-dependence or mechanism ("global heating"?) or material?
- No "Q-drop" observed in low frequency, low beta cavities,even though the peak magnetic fields are quite high: field distribution, different mechanism?

- The Q-drop similar in TM_{010} and TE_{011} mode
- T-maps show "hot spots" in high H-field region

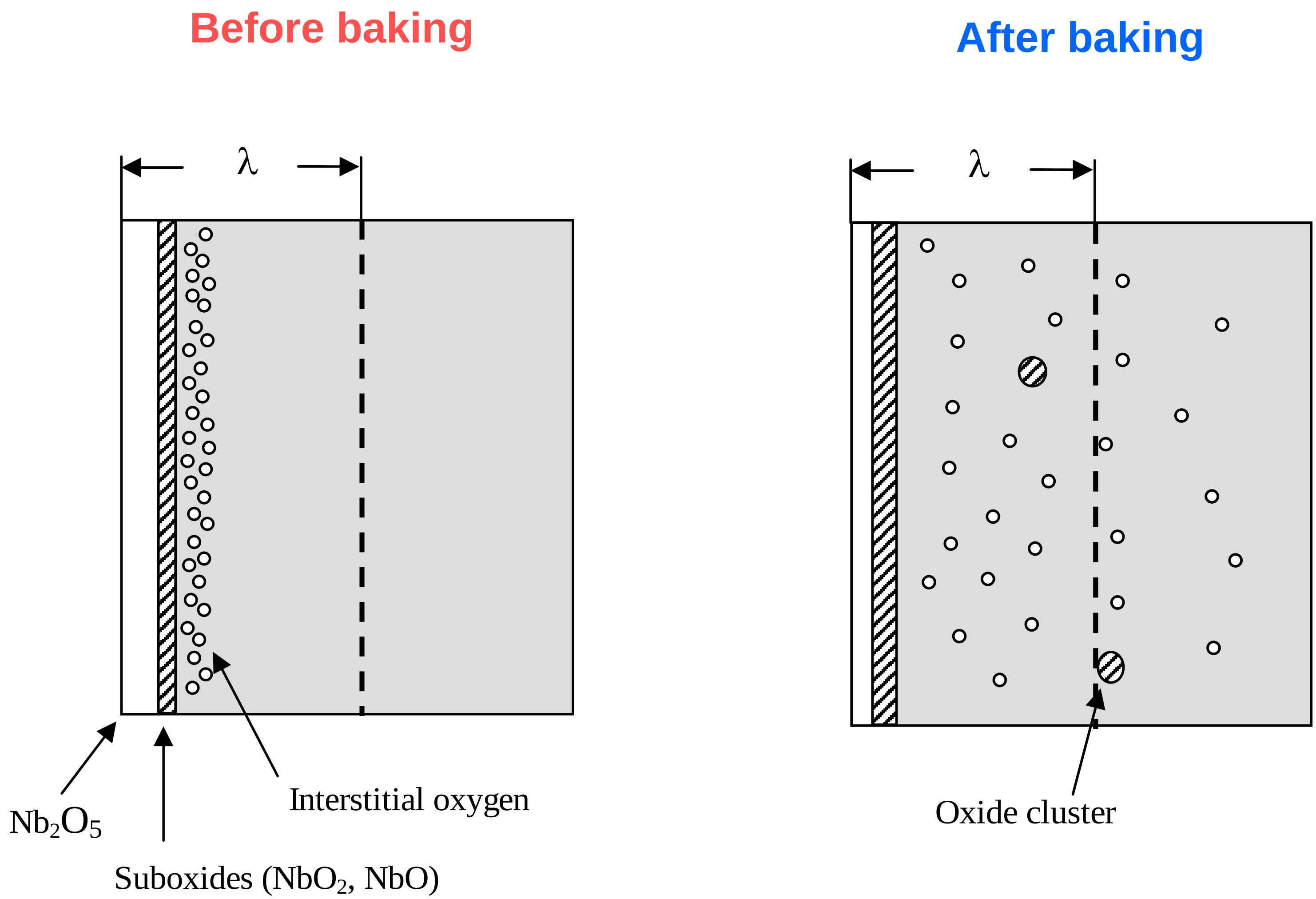
  The Q-drop is due to high magnetic field

- Baking decreases l,RRR,R_{BCS},increases Δ
- Surface studies,magneto-optics, suszeptibility measurements point to

  oxygen diffusion = reduction of O concentration near surface as cause for reduction of Q-slope during baking

- Flux penetration might occur at grain boundaries

Schematic of the Nb surface



- Oxygen diffusion changes κ-value
- B_{c1} reduced
- Surface barrier prevents flux penetration even above B_{c1}
- Surface barrier for flux penetration is reduced for rough surfaces(BCP,fine grain), but is larger for smooth surfaces(EP,larger grains)
- Therefore increase in onset-field

New Models

Q-drop explained on the basis of

- Non-linearity of BCS surface resistance + hot spots in surface (A. Gurevich)
- Overlayer of poor superconductor on good superconductor (E. Palmieri)

Newer Experiments

- Anodizing of nearly "Q-drop-free" surface re-introduces Q-slope

  (G. Eremeev)
- Fast "in air" baking reduces/ eliminates Q-drop (B. Visentin)

Open issues

- Is there enough experimental evidence to exclude H from playing a role in the Q-drop?
- How can we test the hypothesis of flux penetration during Q-drop?
- Interpretation of experimental data against O hypothesis:
  - Saclay data: Q-drop is not restored after HF rinsing of baked cavity (O conc. near surface restored as before baking- is that true?)