New results on the “high field Q-slope”

One of the hottest topics in RF superconductivity

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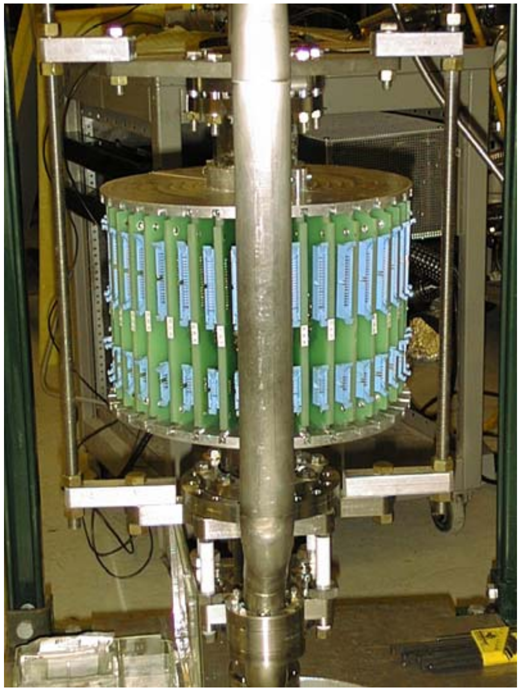
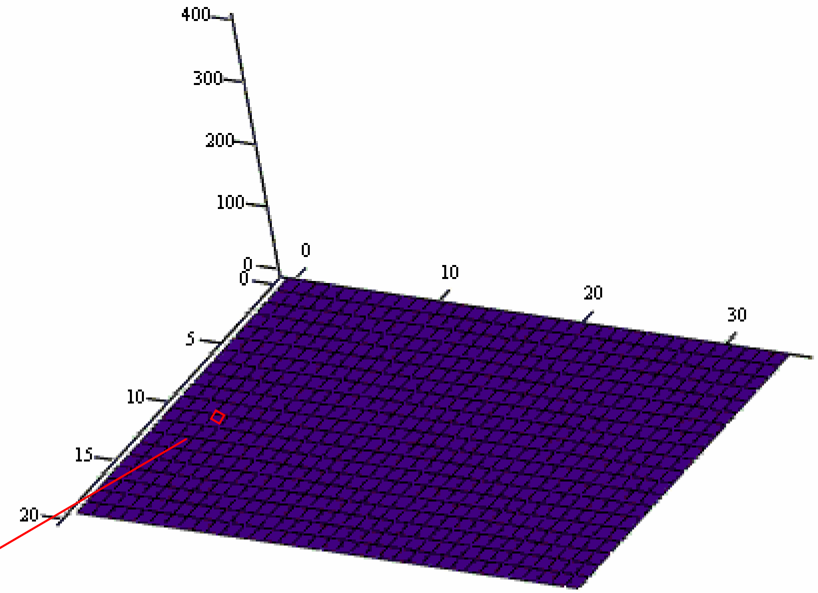
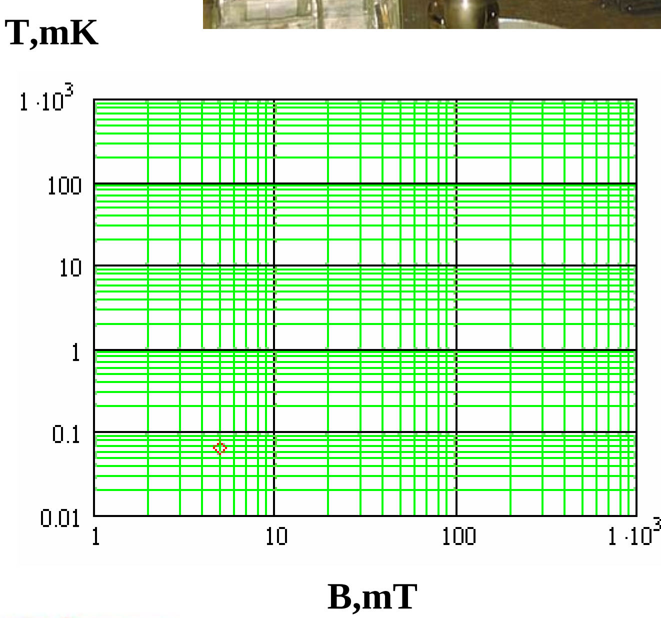
Outline

- **Short presentation of the basic features of the high field Q-slope**
- **Short review of the “oxygen pollution layer” model**
- **Our experiments and interpretation of the results**
- **Conclusions (contradict the “oxygen pollution layer” model)**

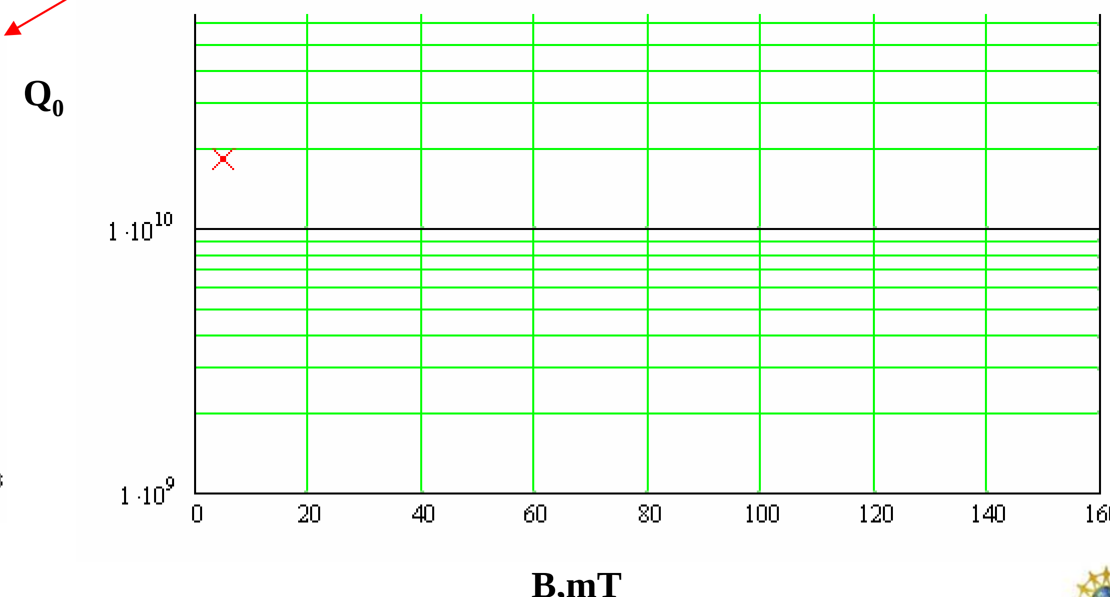




400
300
200
100
0
0
0
10
20
30
5
10
15
20
1



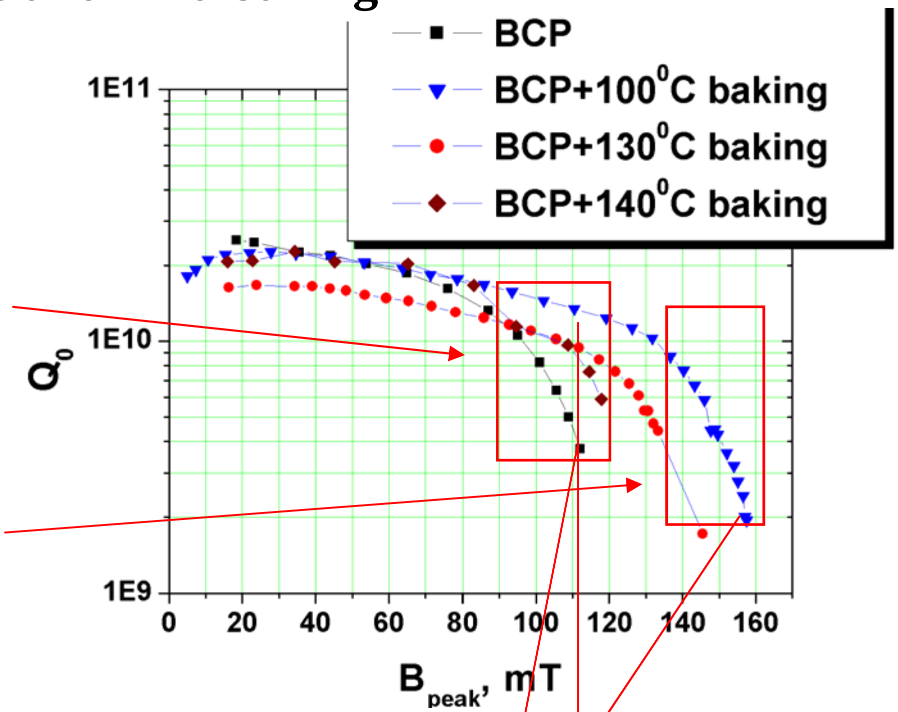
T,mK
1·10^3
100
10
1
0.1
0.01
1
10
100
1·10^3
B,mT

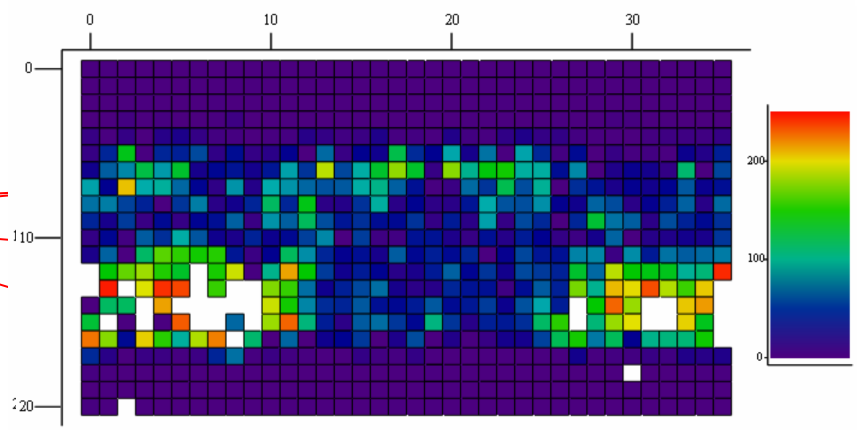


Q0
1·10^10
1·10^9
0
20
40
60
80
100
120
140
160
B,mT

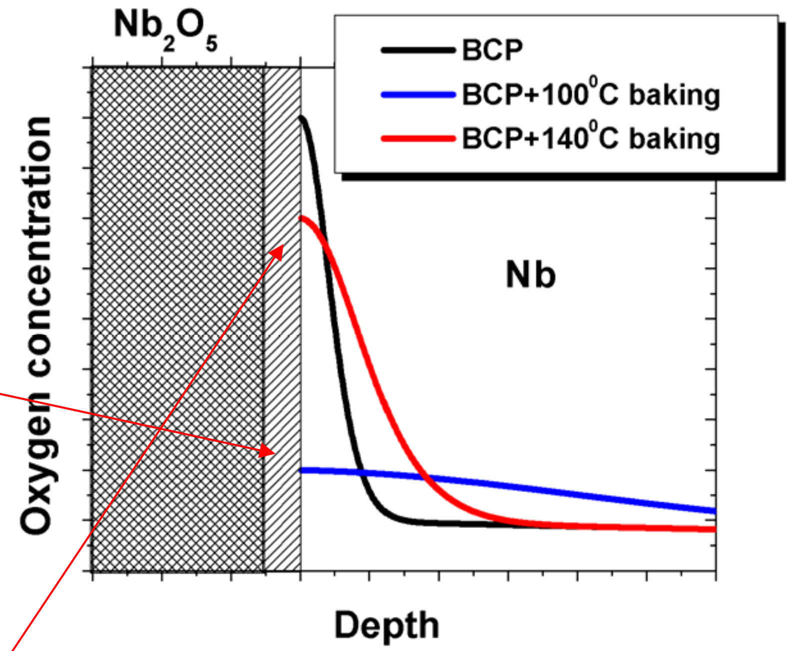
High field Q-slope and mild baking

- Strong quality factor degradation at high fields
- Mild baking removes or pushes Q-slope to higher fields
- Improvement depends upon baking temperature
- Temperature maps show many hot spots in the high magnetic field region





"Oxygen pollution layer" model



- The improvement in the high field Q-slope is due to diffusion of the oxygen from the pollution layer into the bulk at 100^0C

- Higher temperature baking partially modifies pentoxide and enriches RF layer with oxygen

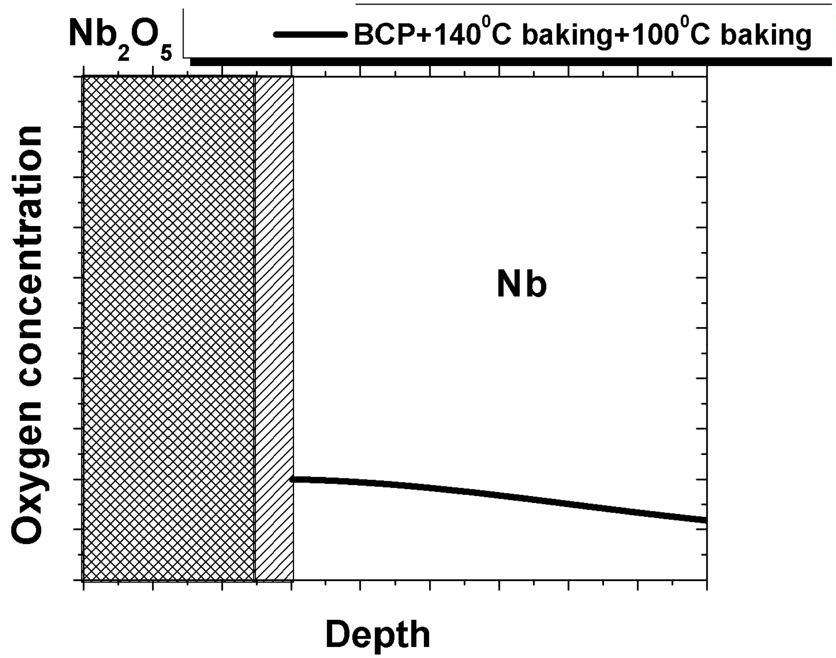
Support to “oxygen pollution layer” model

- The mild baking effect suggests that a diffusion process is involved; after hydrogen, oxygen is the most mobile impurity.

- Dissolved oxygen lowers the critical temperature of niobium.

- The existence of “oxygen pollution layer” and its modification after baking is supported by surface studies.

130^0C-100^0C baking idea



First we will bake a cavity at high temperature, so that oxygen concentration stays high due to break up of pentoxide, but then we will bake at lower temperature to see if we will get better performance.

The idea was to remove "oxygen pollution layer" after high temperature baking by lower temperature baking

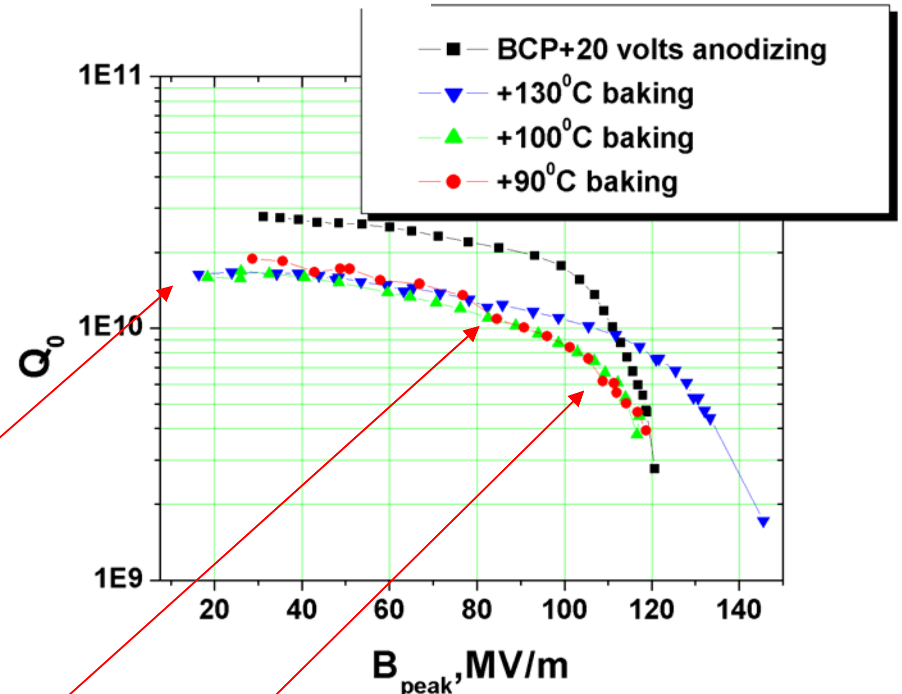
130^0C-100^0C baking experiment

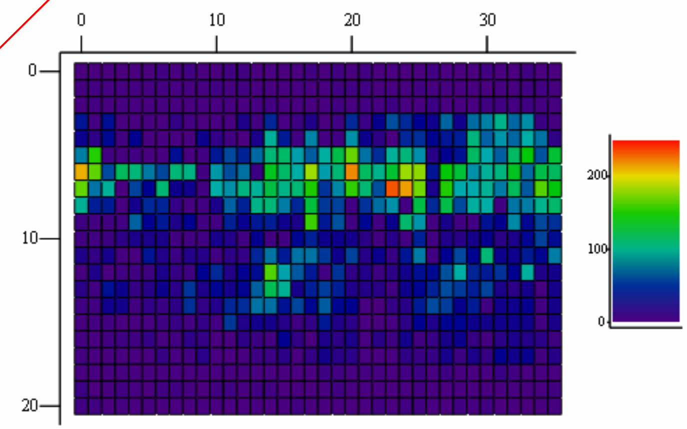
1. We took cavity after fresh BCP(500 RRRR).

2. We baked the cavity at 130^0C

3. We baked the cavity at 100^0C

4. We baked the cavity at 90^0C

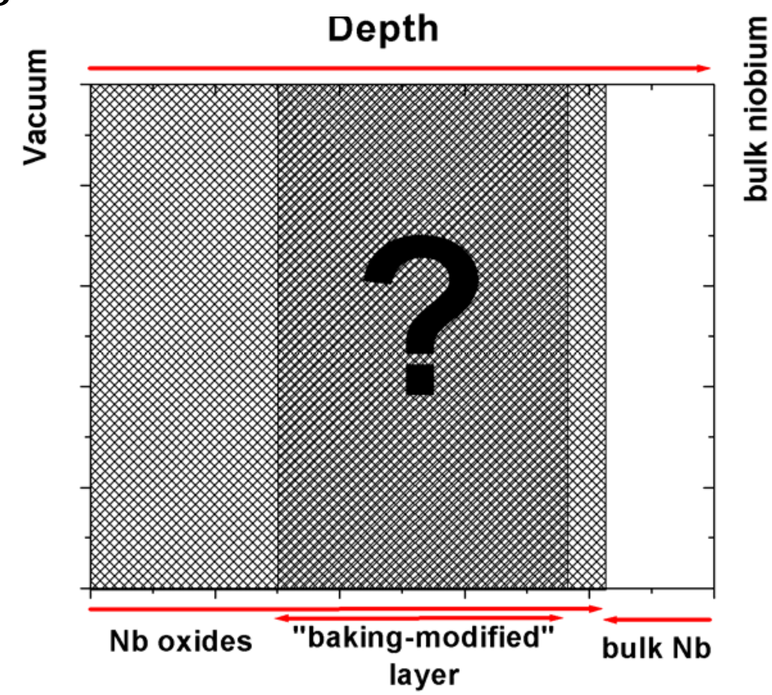




Anodizing idea

Sequential anodizing shows that after baking BCS resistance goes down over the depth of 300 nm, presumably, due to diffusion of oxygen (P.Kneisel et al.)

“New idea”: By applying anodizing we will grow pentoxide and eat up “baking modified layer”



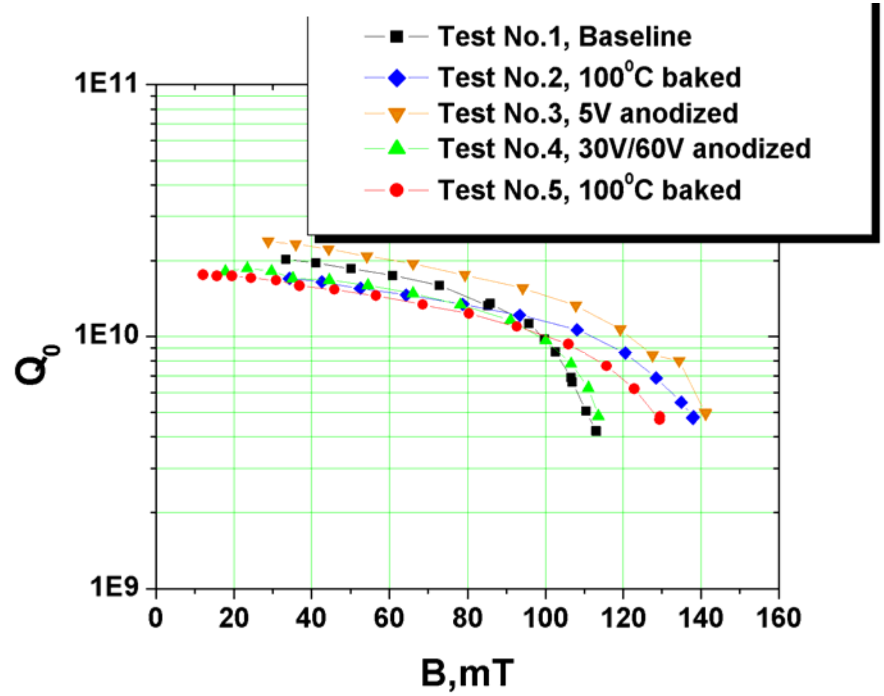
The idea was to probe mild baking effect by step-by-step anodizing of a baked cavity

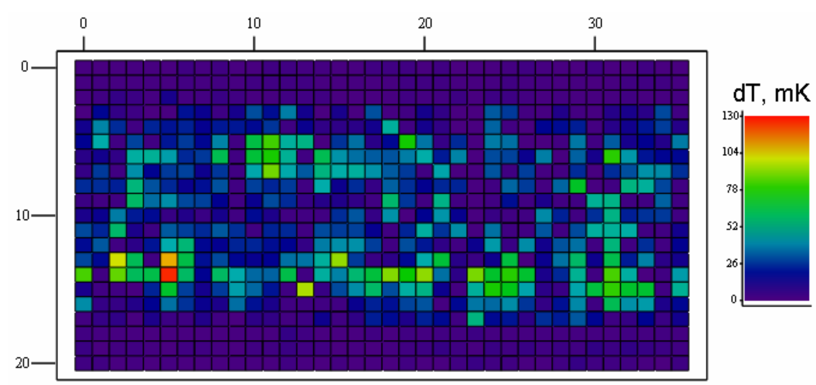
Anodizing experiment with BCP

5 volts anodizing doesn't alter performance of a baked cavity.

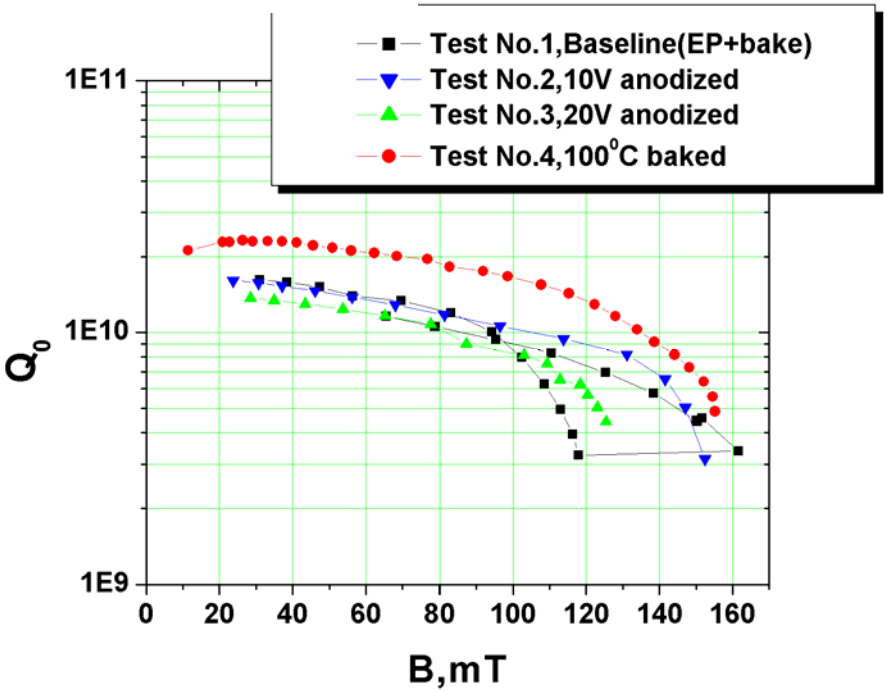
After 30/60 volts anodizing cavity behaves like before baking.

100^0C baking improves performance again.





Similar effect for EP



After 10 volts anodizing the performance of a baked EP cavity is almost the same.

20 volts anodizing makes performance of a baked EP cavity with a strong Q-slope.

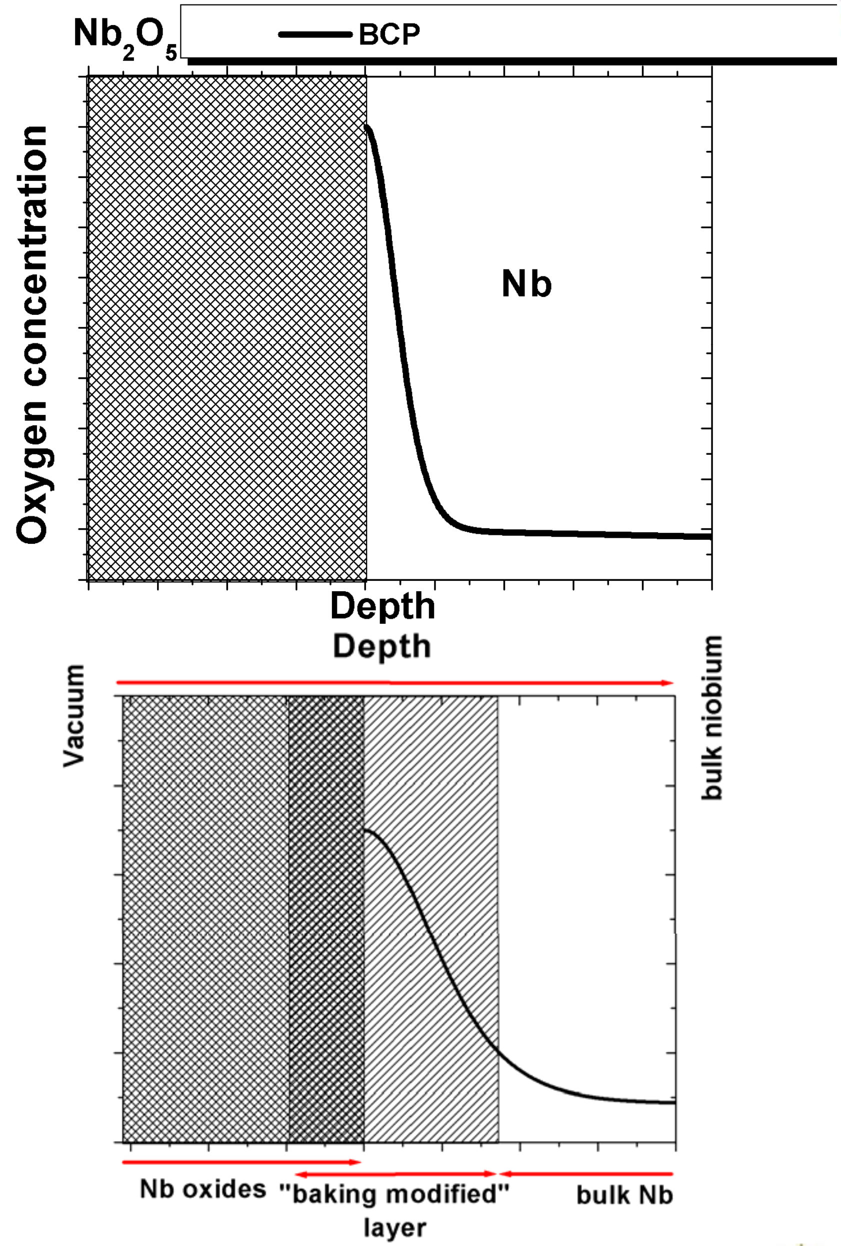
100^0C baking improves cavity performance.

5 volts anodizing

The known fact is that anodizing of unbaked cavity doesn't change its performance, that in the

But if anodizing introducing "oxygen pollution", then how could the baked BCP[EP] cavity performance after 5[10] volts "anodizing" stay the same [nearly]?

The framework of "oxygen pollution layer" means that "oxygen pollution layer" created by anodizing is similar to that created by natural oxidation.



Conclusions

- **The depth of the baking benefit is about 60 nm, not 300 nm like mean free path effect.**
- **This interpretation of experimental data contradicts the "oxygen pollution layer" model.**
- **The 5 volts anodizing experiment questions "oxygen pollution layer" as a cause for the high field Q-slope.**
- **Is it really oxygen? The 60 nm baking benefit depth suggests some other impurity, which diffuses slower than oxygen?**
- **This afternoon my poster will give more information on temperature maps for these experiments**