dapnia

cea

saclay

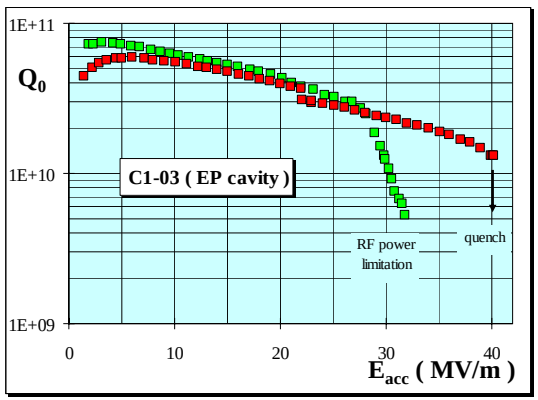
International Linear Collider

Optimization of the Baking Process for I L C Project

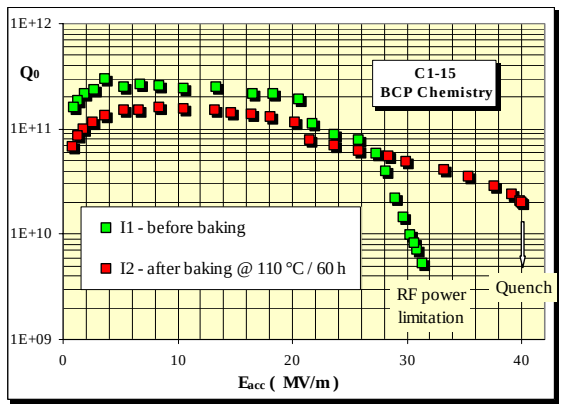
Bernard VISENTIN

Baking ≡ Recipe for high gradients

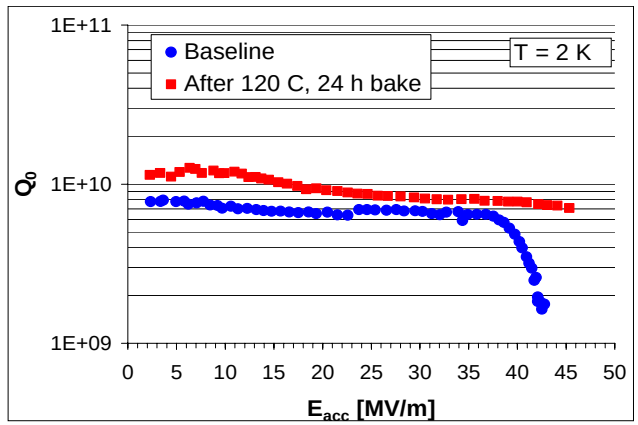
T = 110 - 120 °C t = 1 - 2 days (Narrow Tuning Range)



1.3 GHz - Saclay / KEK
Electropolishing
Poly-crystal



1.3 GHz - Saclay
Chemical etching
Poly-crystal



2.2 GHz - JLab
Chemical etching
Single crystal

Whatever the niobium structure... (Single or Poly-crystal,)

Whatever the fabrication method...(EB Welding or Hydroforming, bulk Nb or clad Nb/Cu)

Whatever the chemical treatment... (Electropolishing or Buffered Chemical Polishing)

Standard Preparation

Heat Treatment 800°C (H) / 1300°C+Ti (O-K_T)

Ultrasonic Grease Remover

Chemical Etching (BCP) – FNP (1:1:2)
Electropolishing (EP)

Ultra pure Water Rinse

Clean Room
(Class 100)

- High Pressure Rinse - 85 bars (FE)
- Air-Drying : **RT – 3 hours**
- Assembly + Helium Test

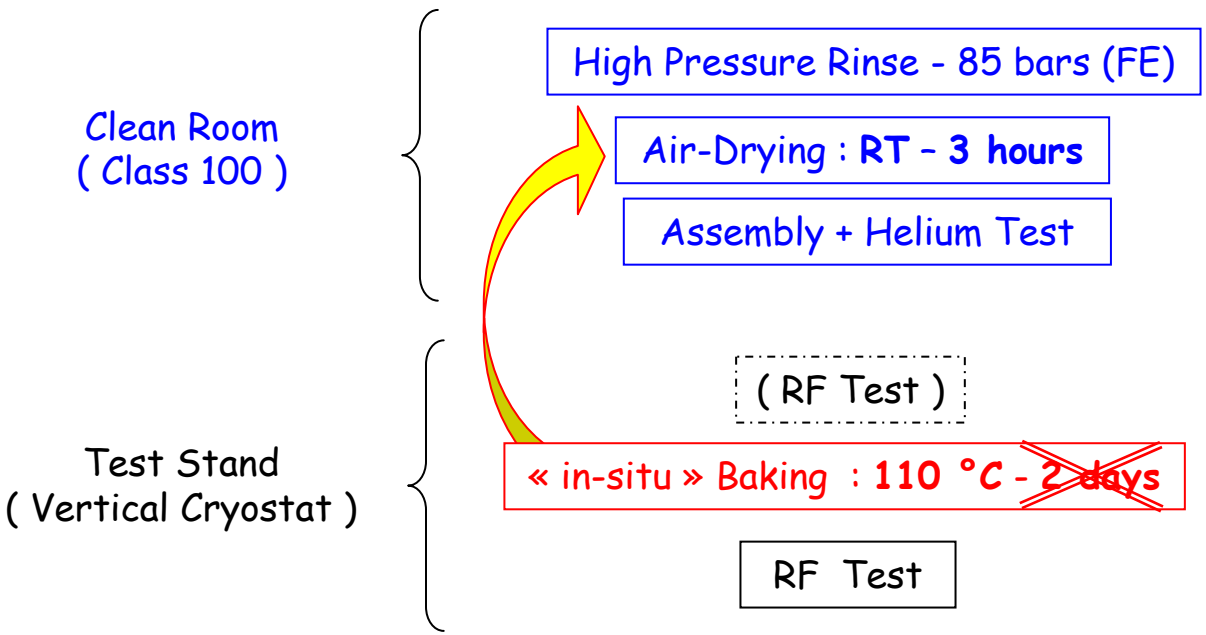
Test Stand
(Vertical Cryostat)

- (RF Test)
- « in-situ » Baking : **110 °C - 2 days**
- RF Test

« In-Situ » Baking

unadapted to

Cavity Mass Production



save time:

decrease Baking Duration

risk of helium leaks (∝ T)
for final RF test:

Baking before Assembly

save step:

Drying with Baking

Hot Air - Drying

well adapted to

Cavity Mass Production

Clean Room
(Class 100)

- High Pressure Rinse - 85 bars (FE)
- Hot Air-Drying : **T – 3 hours**
- Assembly + Helium Test

Test Stand
(Vertical Cryostat)

- RF Test

save time:

decrease Baking Duration

risk of helium leaks ($\propto$ T)
for final RF test:

Baking before Assembly

save step:

Drying with Baking

High Field Q-Slope Improvement ?

	« In-Situ » Baking	Modified Baking
avoid leaks	Ultra High Vacuum	Air (before assembly)
save time	48 - 60 h (110 °C)	3 hours (T ?)
combine with drying	Dry cavity	Wet cavity (under laminar flow)

Some of these verifications have been already done,

R & D goes on for the others…

Air-Drying
(RT → T ?)

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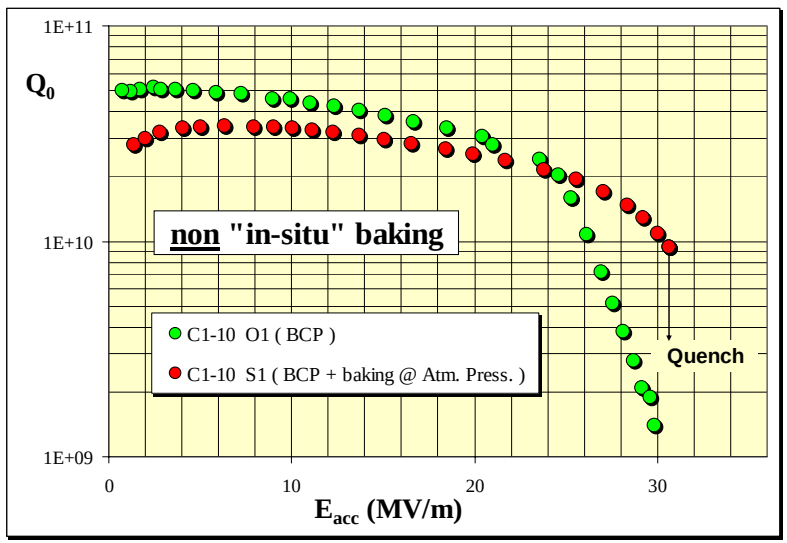
« UHV » → « Air » Baking

Cavity open-ended in Stove

(room atmosphere - atmospheric pressure)

110 °C
60 hours
+ HPR



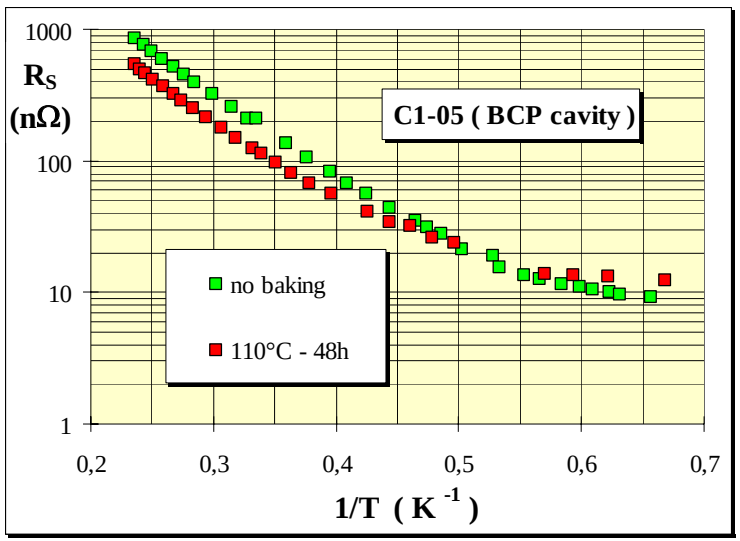
How to Decrease the Baking Duration ?

O diffusion modifies surface resistance R_S trough $R_{BCS}(\ell)$

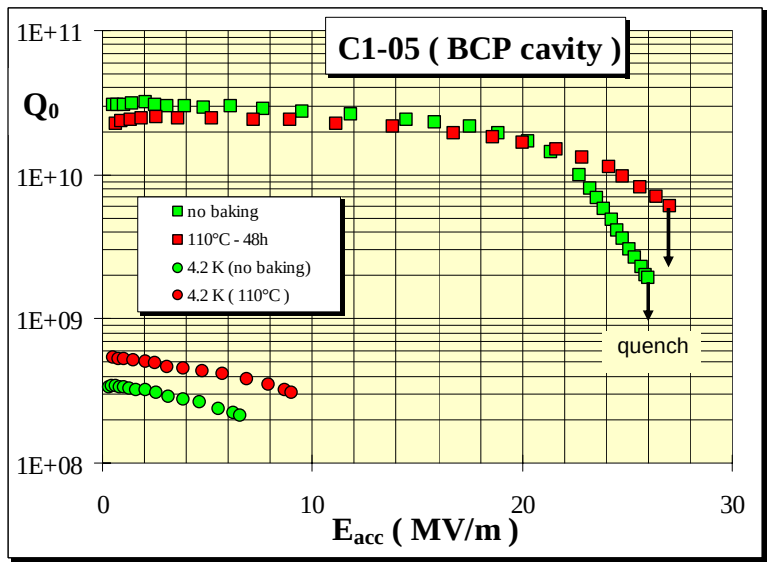
$$R_S = R_{res} + A(\lambda_L, \xi_F, \ell)\frac{\omega^2}{T}e^{-\Delta/kT}$$

High Field Q-slope improvement : <u>mechanism is still unknown</u>

Hypothesis : O diffusion is involved



110 °C
60 hours
(UHV)



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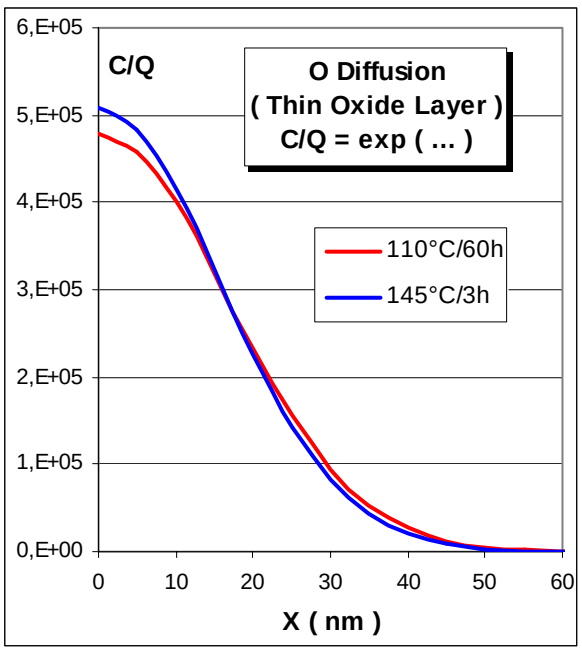
Oxygen Diffusion Parameters (T , t)

$$\frac{\partial c}{\partial t} = D_0 \, e^{E_A/RT} \, \frac{\partial^2 c}{\partial x^2}$$

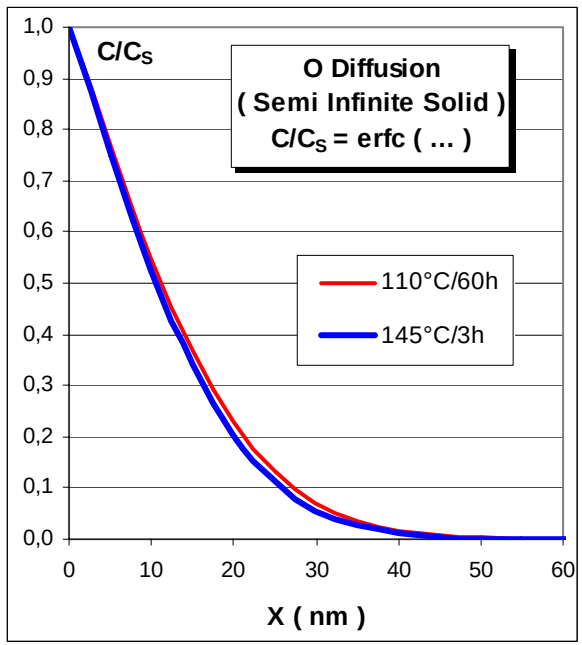
2nd Fick's law → analytic



110 °C / 60 hours

↔

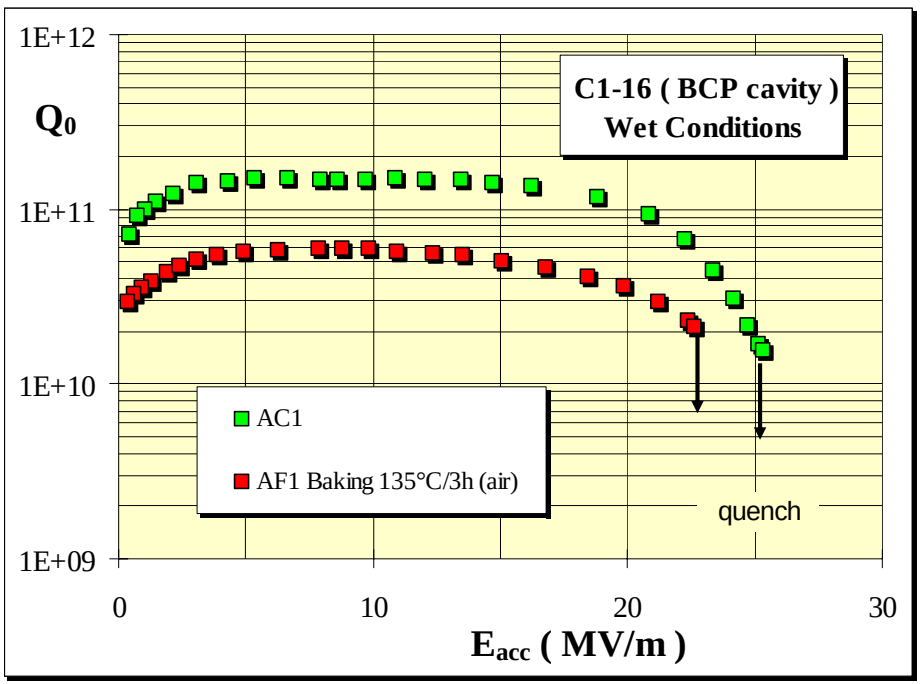
145 °C / 3 hours



thin oxide layer : $C(x,0) = Q\,\delta(x)$

semi infinite solid : $C(0,t) = C_S$

Fast Air-Baking on Wet Cavity



Very Bad Results

wrong hypothesis : diffusion (T, t) ?
surface degradation in stove ?
H_2O on surface ?

160 °C
145 °C
135 °C

3 hours
+ HPR

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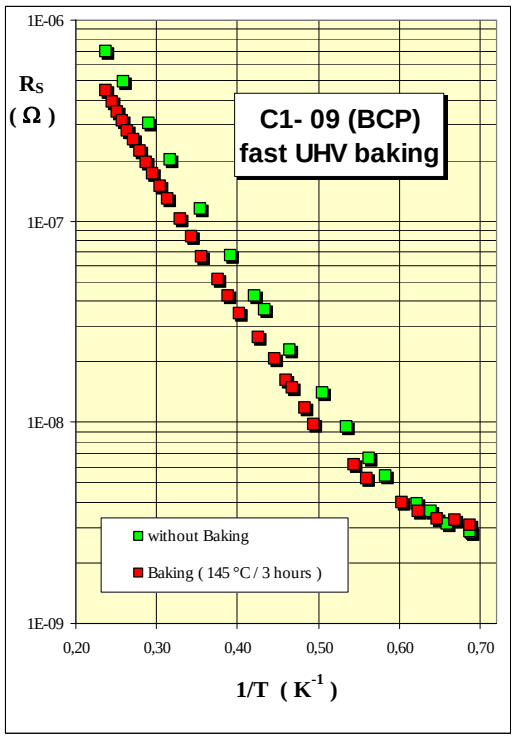
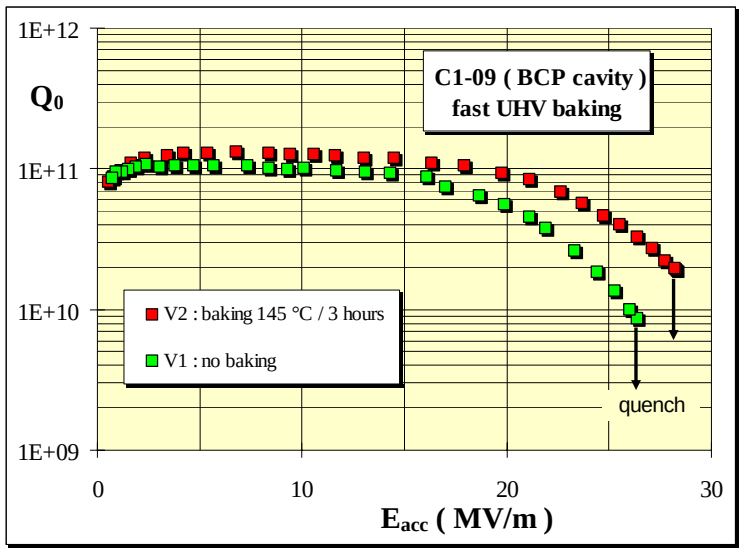
« Fast » Baking (UHV)

- Cavity pumped out (Ultra High Vacuum)
- Infra-Red emitters (T : short rise time)





145 °C - 3 hours
Right Hypothesis
Q-slope ↔ O diffusion

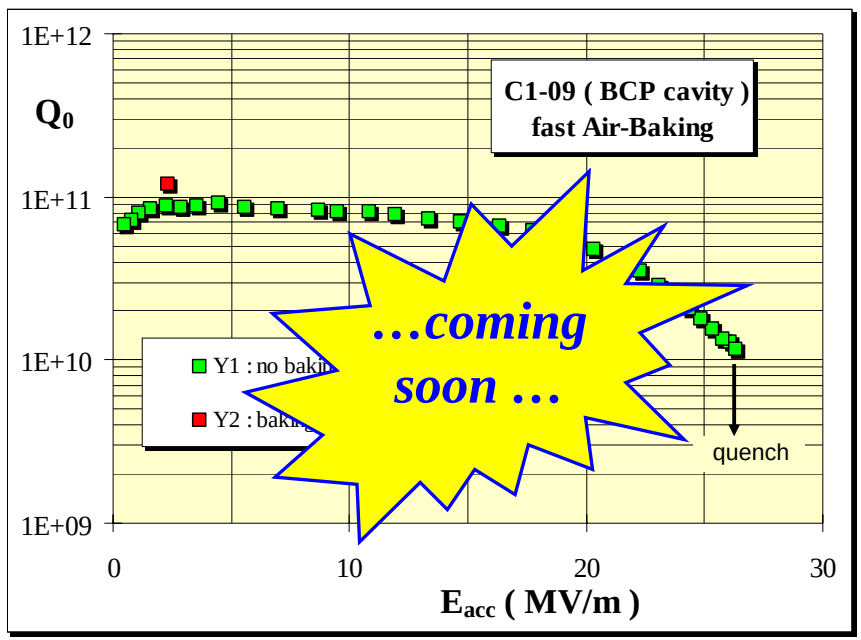
« Fast » Baking (Air)

- Cavity open-ended

  (Clean Room Atmosphere – Laminar Flow)

- Infra-Red emitters

145 °C
3 hours
+ HPR



Air contribution ?

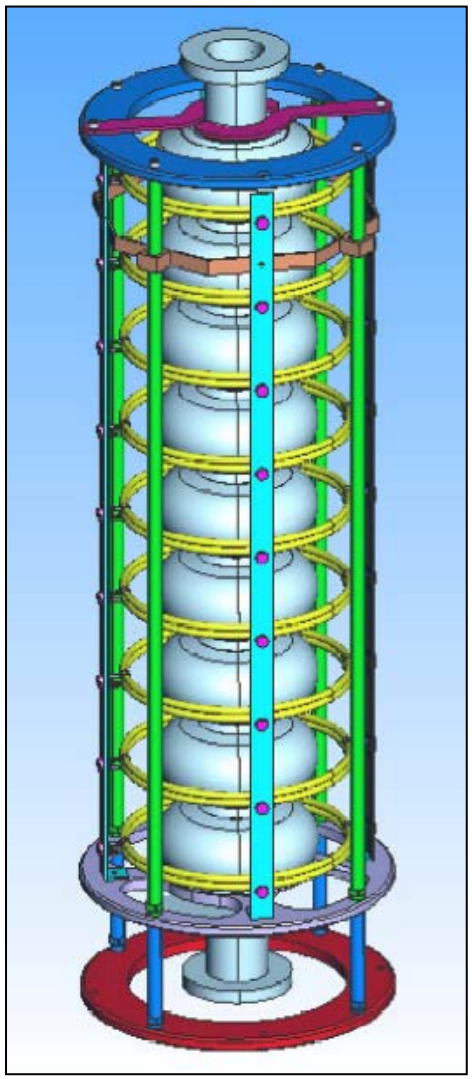
(@ T > 110°C)

Advances towards « Hot Air-Drying »

Baking + Air-Drying @ RT

« In-Situ » Baking		Fast Air-Baking
Ultra High Vacuum	→	Air
48 - 60 h (110°C)	→	3 hours (145°C)
Dry cavity		Wet cavity

Solve Disturbances of Laminar Flow → Air-Drying @ 145 °C



from 1-cell to 9-cell Cavities …?…

Not a Problem !

System with I R emitters

could be easily adapted

…….