Preliminary Results from Large Grain and Single Crystal Niobium cavities

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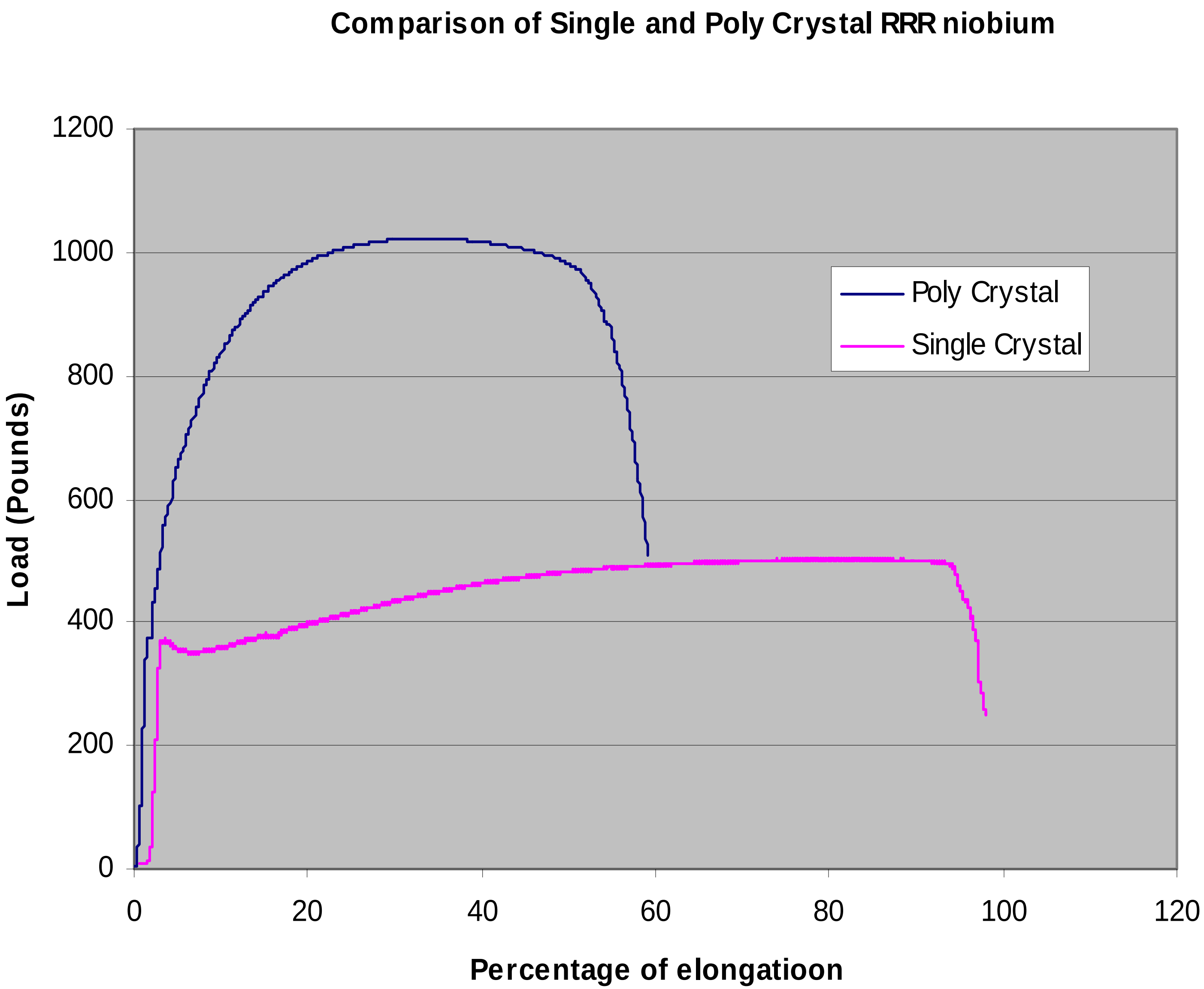
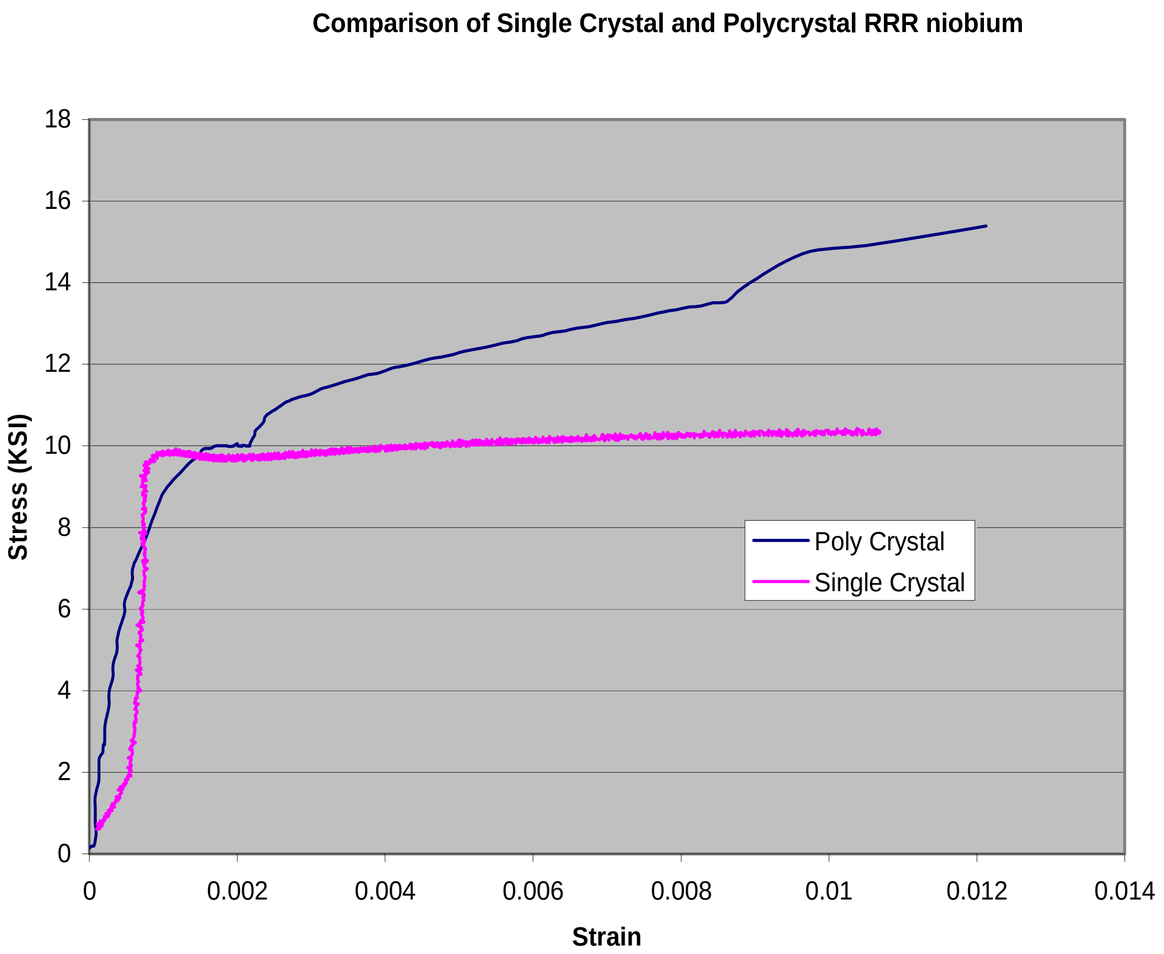
Single Crystal Niobium(1)

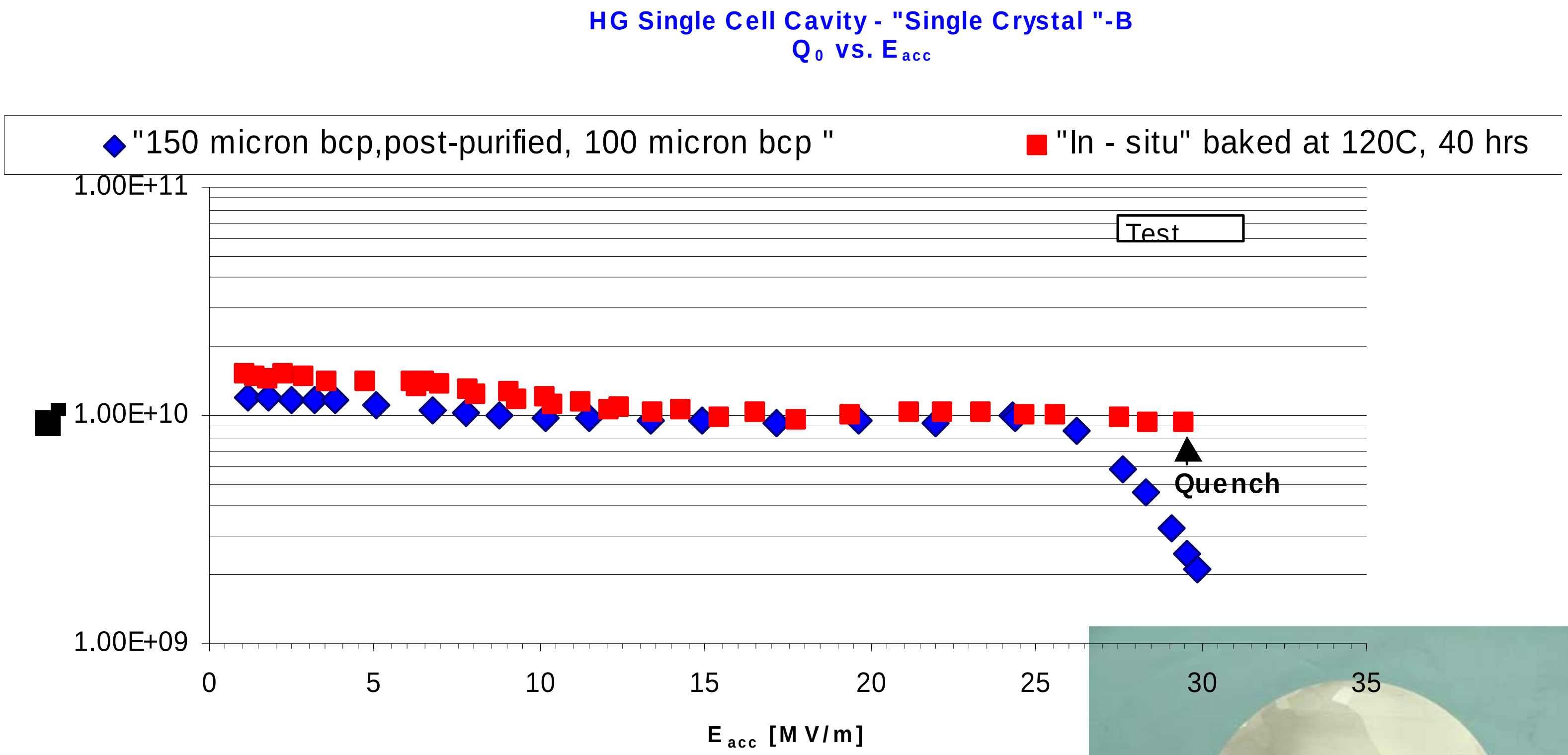


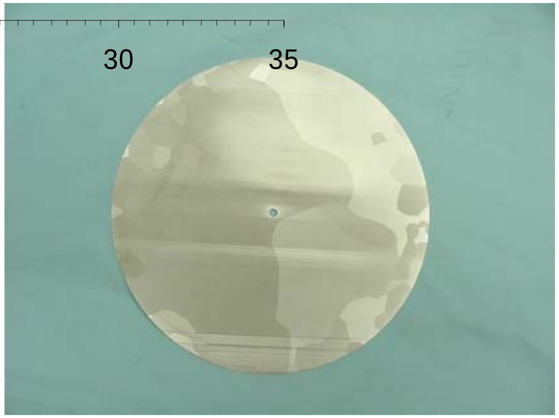
Single Crystal Niobium (2)



Large Grain Niobium (1.5 GHz)

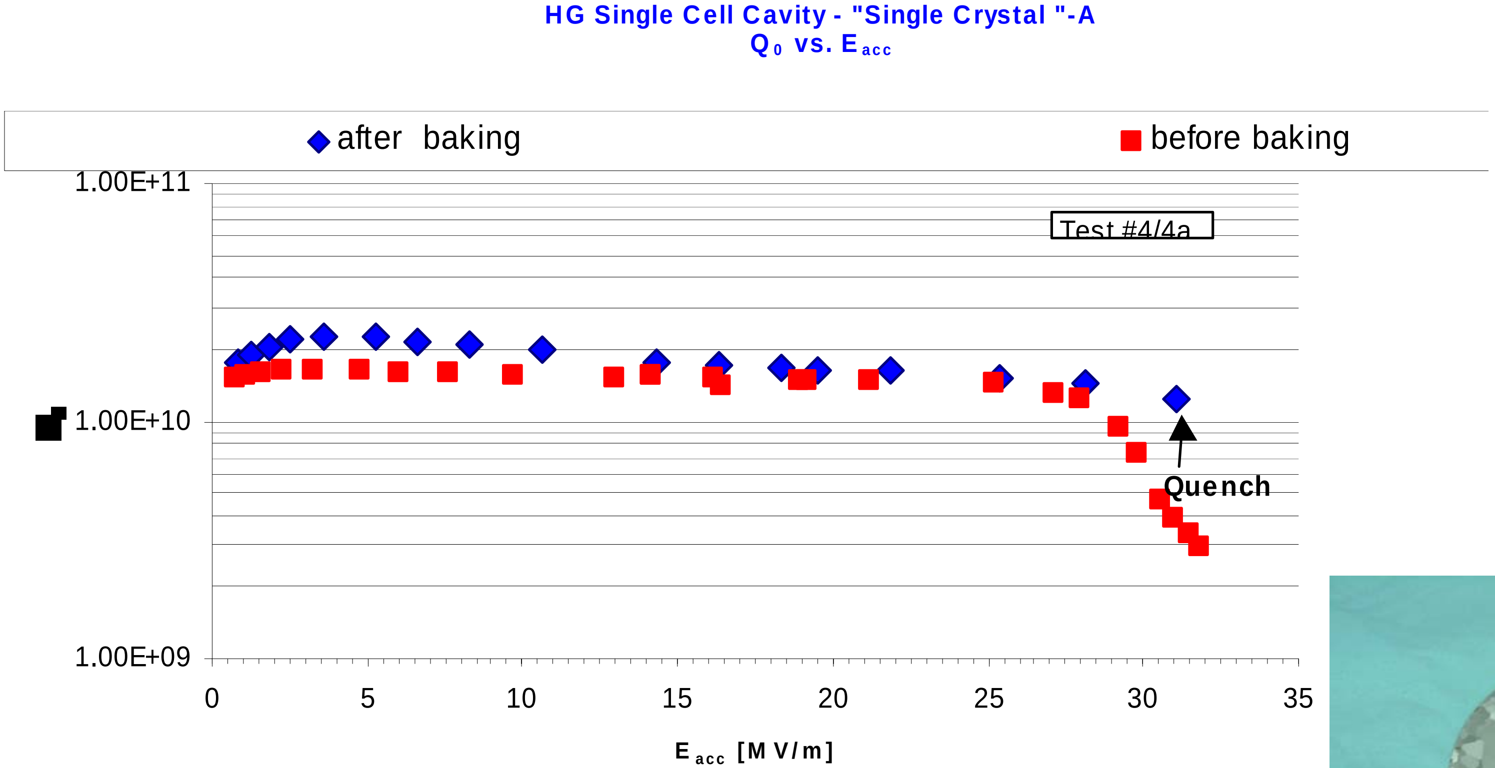
Ingot "B"

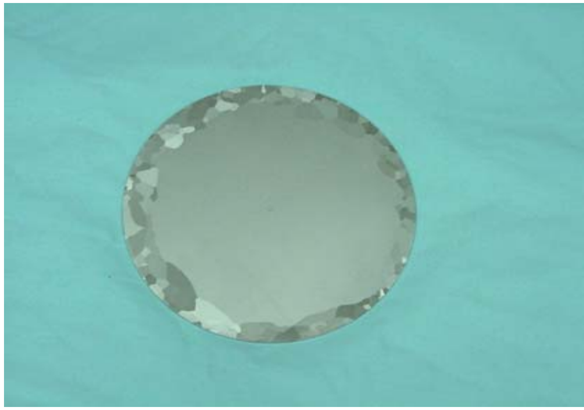




Large Grain Niobium (1.5 GHz)

Ingot "A"





Single Crystal Niobium Cavity (1)

Discs from Ingot

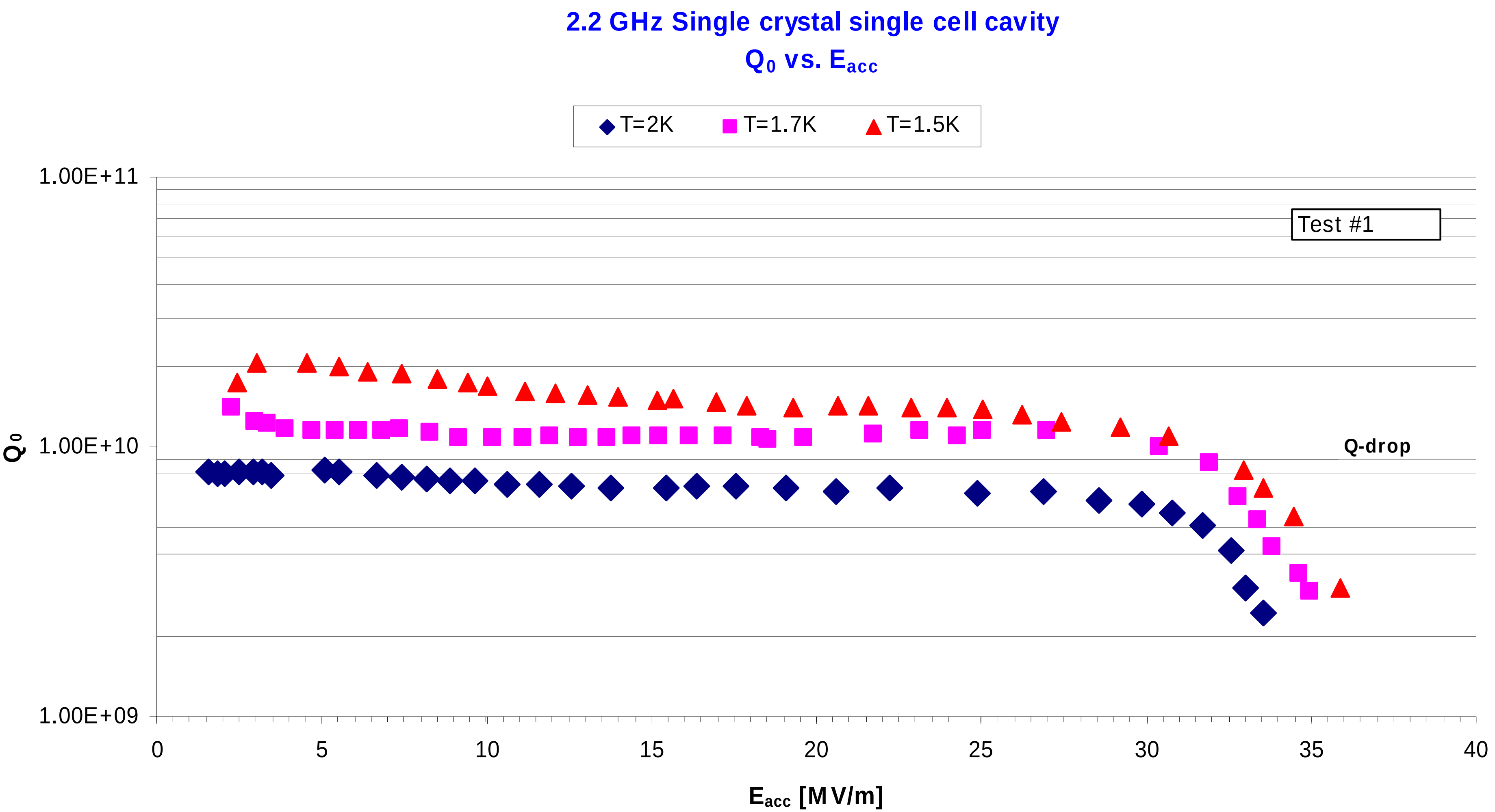
Cavity

$E_{peak}/E_{acc} = 1.674$

$H_{peak}/E_{acc} = 4.286$ mT/MV/m

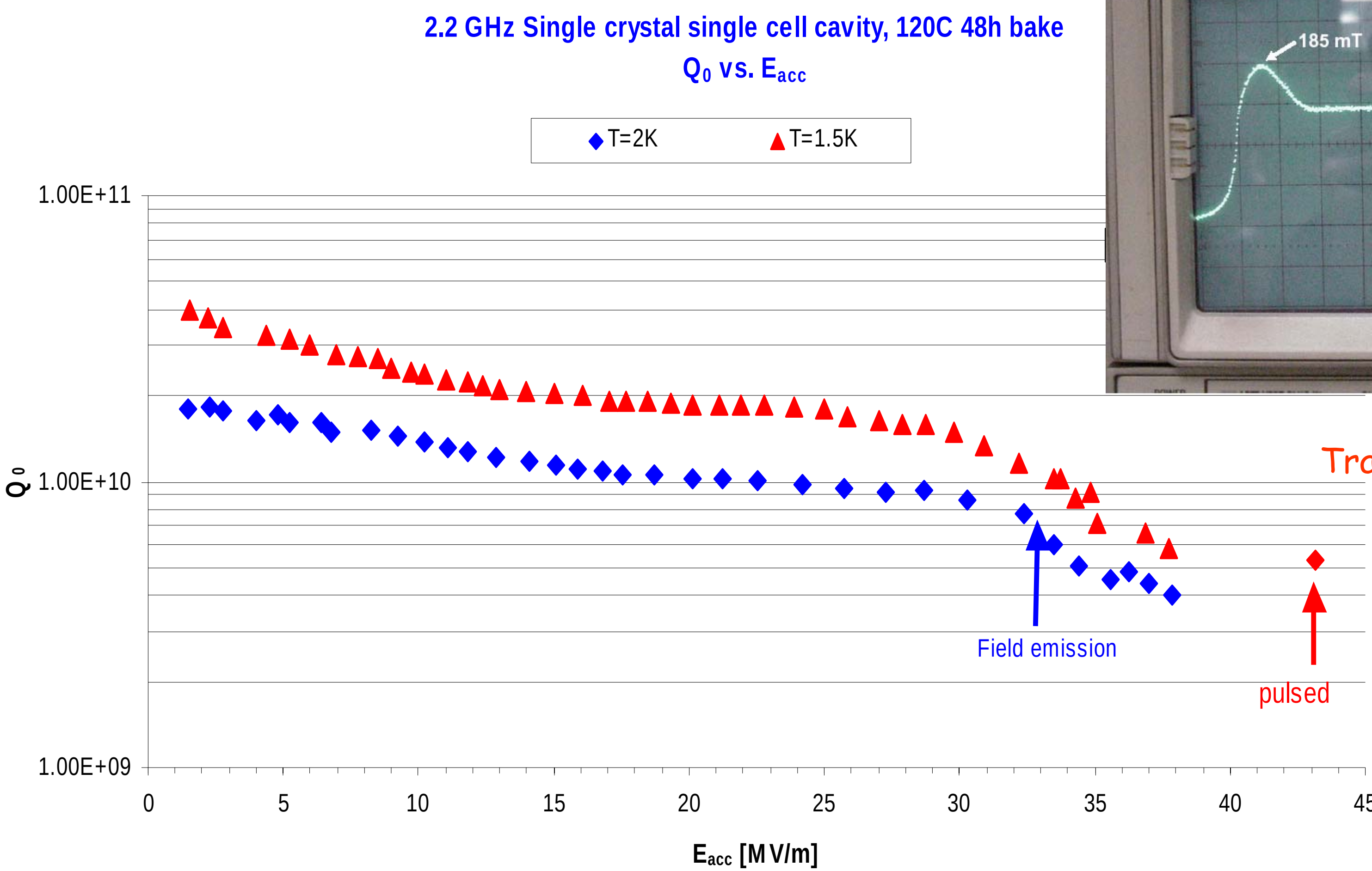
Single Crystal Niobium Cavity (2)

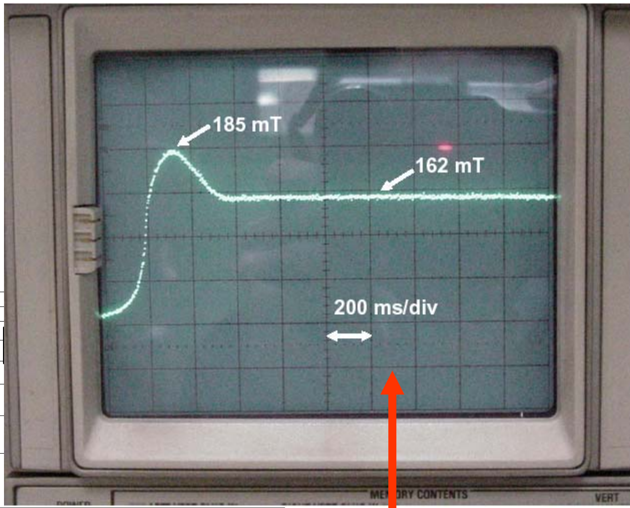
Test #1a: Treatment 100 μm BCP, 800C hydrogen degassing, 100 μm BCP, high pressure rinsing for 30 min



Single Crystal Niobium Cavity (3)

Test #1b: Treatment 100 μm BCP, 800C hydrogen degassing, 100 μm BCP, high pressure rinsing, "in situ" baked at 120C for 48 hrs

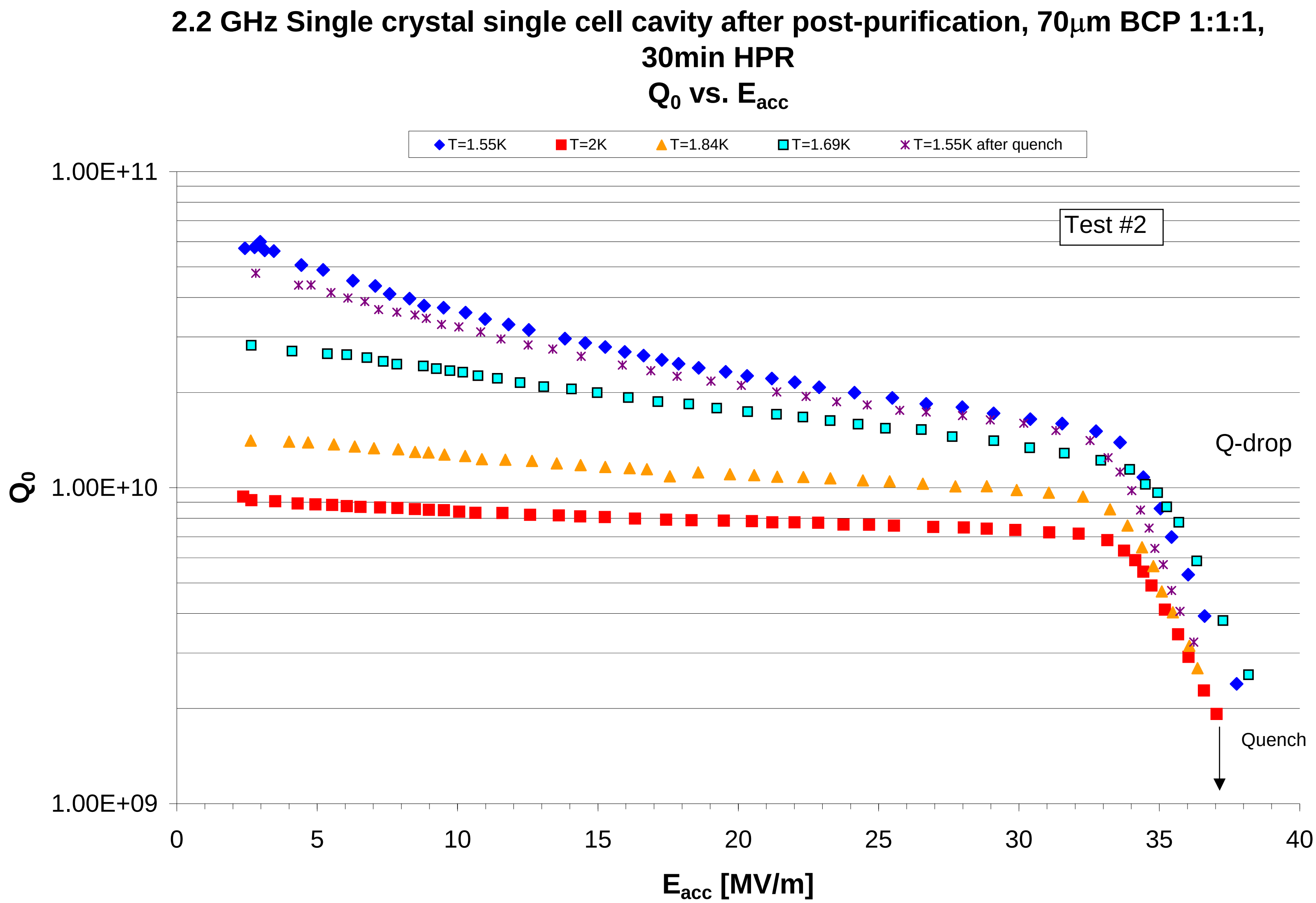




Transmitted signal

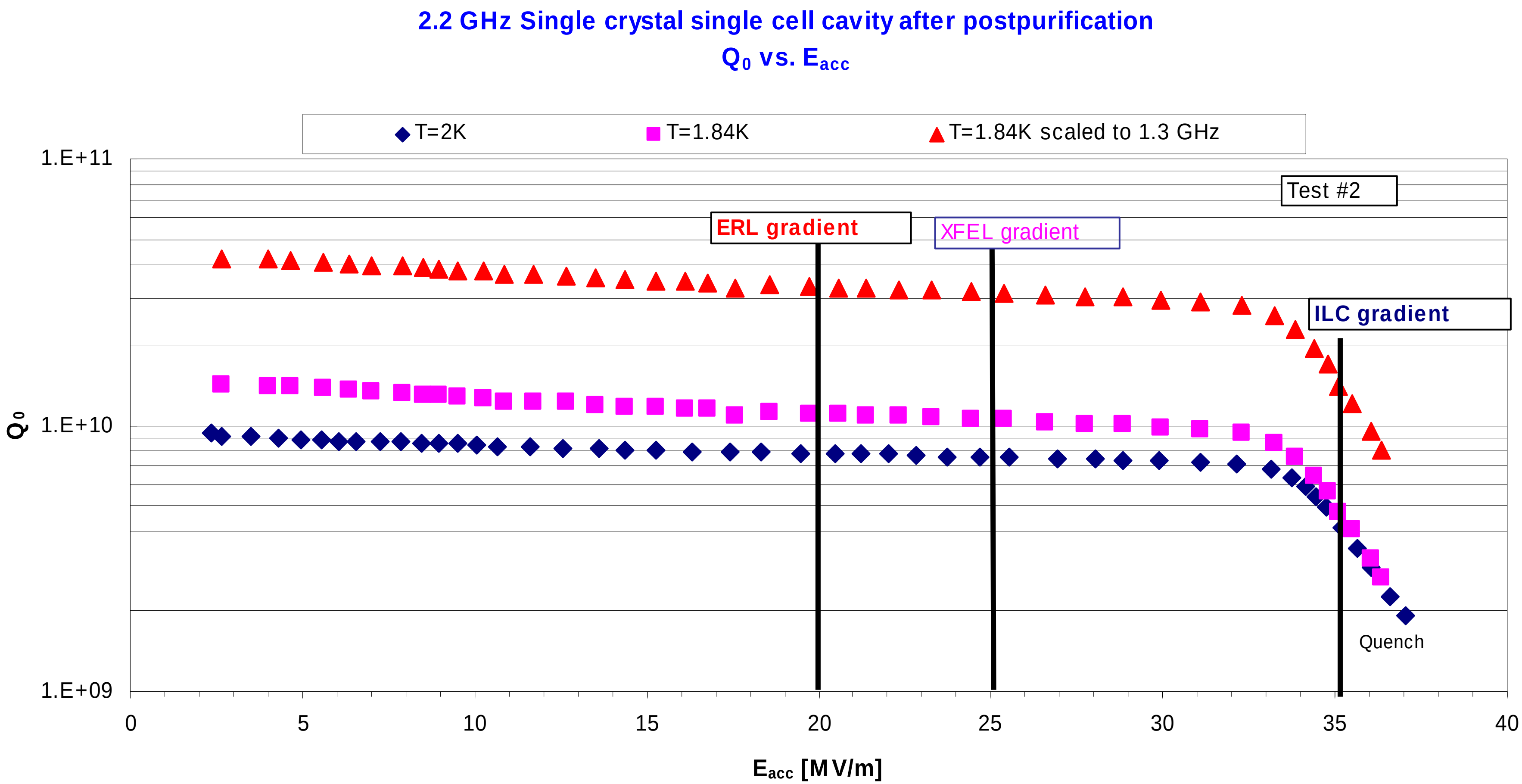
Single Crystal Niobium Cavity (4)

Test #2(before baking)



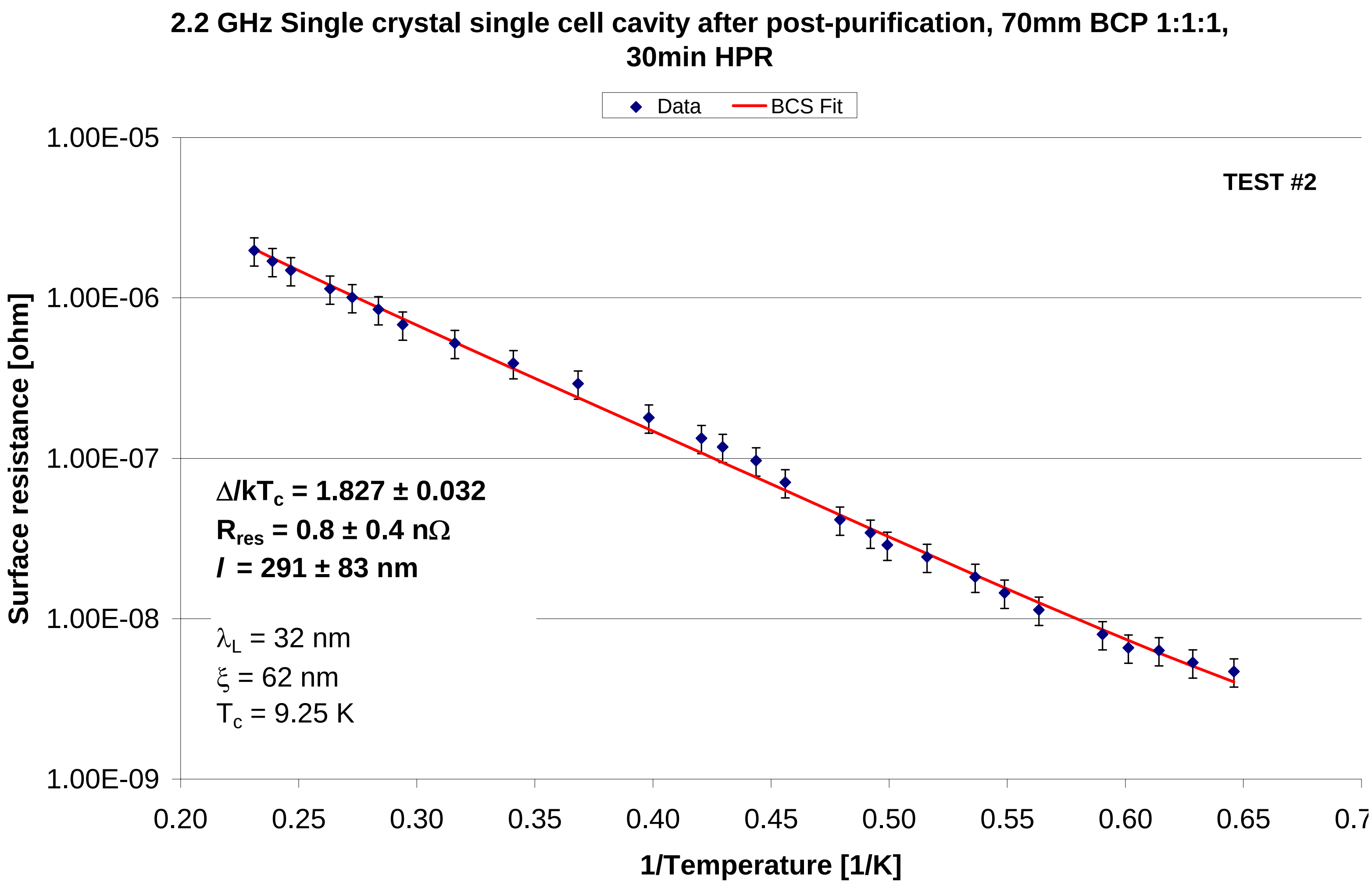
Single Crystal Niobium Cavity (5)

Test #2: post-purification heat treatment at 1250 C for 10 hrs, 100 μm BCP ,high pressure rinsing



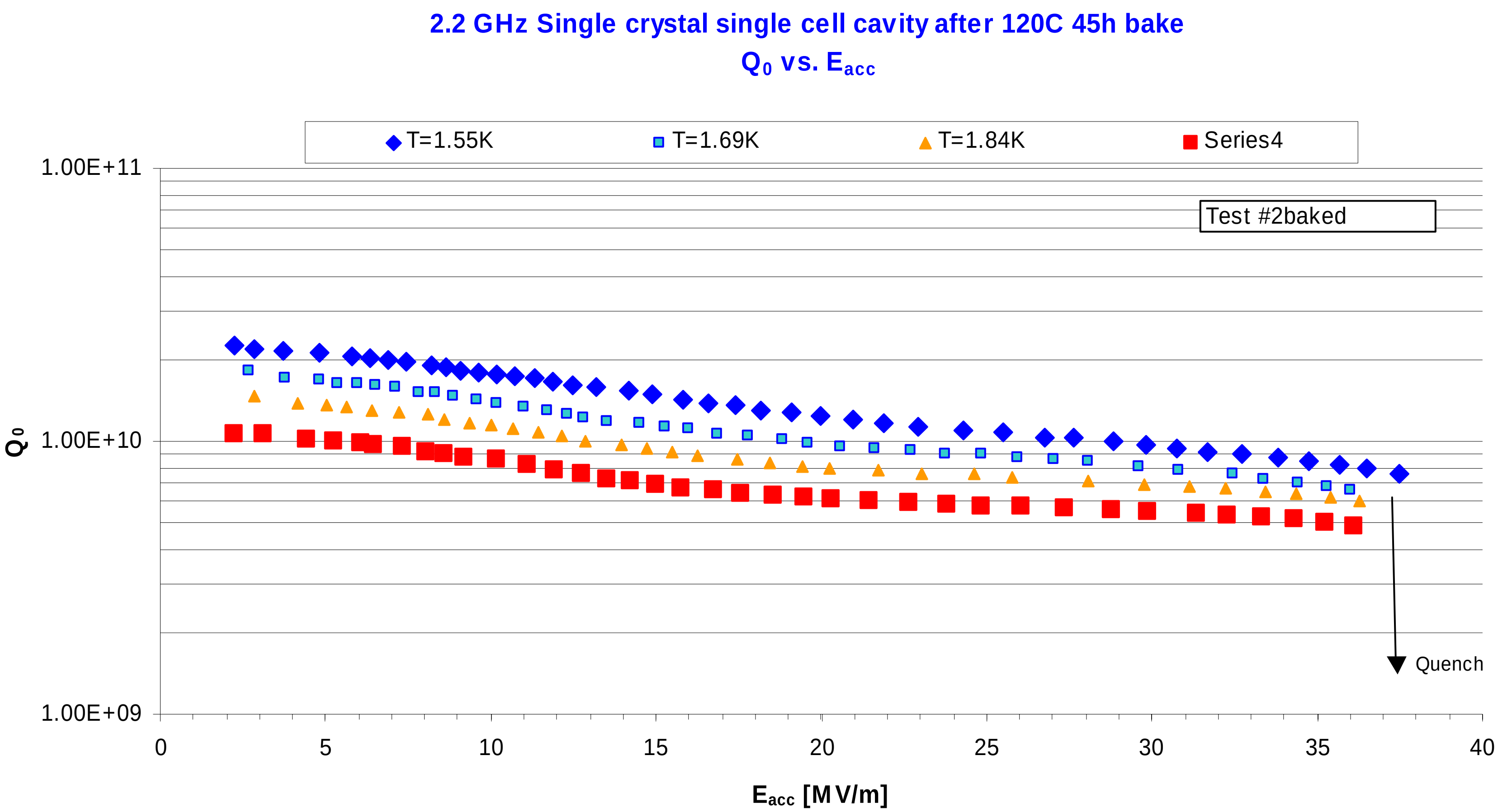
Single Crystal Niobium Cavity (6)

Test #2: T-dependence (before baking)



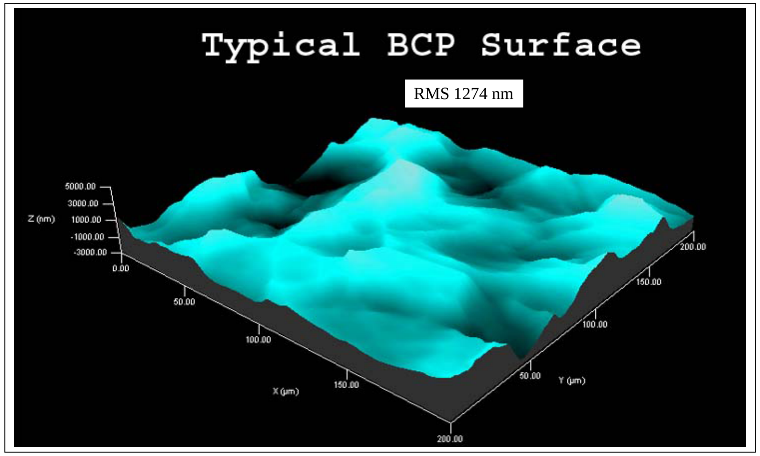
Single Crystal Niobium Cavity (7)

Test #2:after baking at 120C, ~44 hrs



Single Crystal BCP

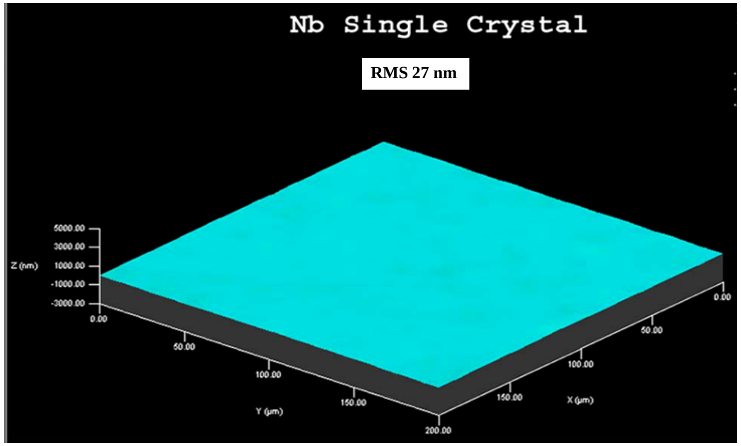
Provides very smooth surfaces as measured by A.Wu, Jlab

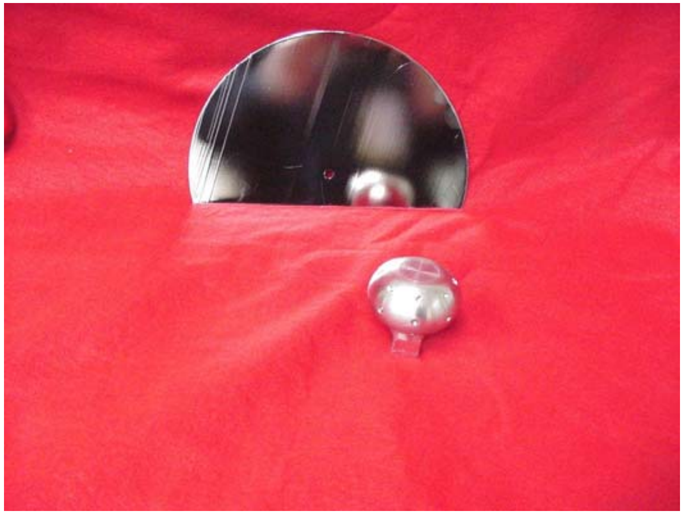


RMS: 1274 nm fine grain bcp

27 nm single crystal bcp

251 nm fine grain ep

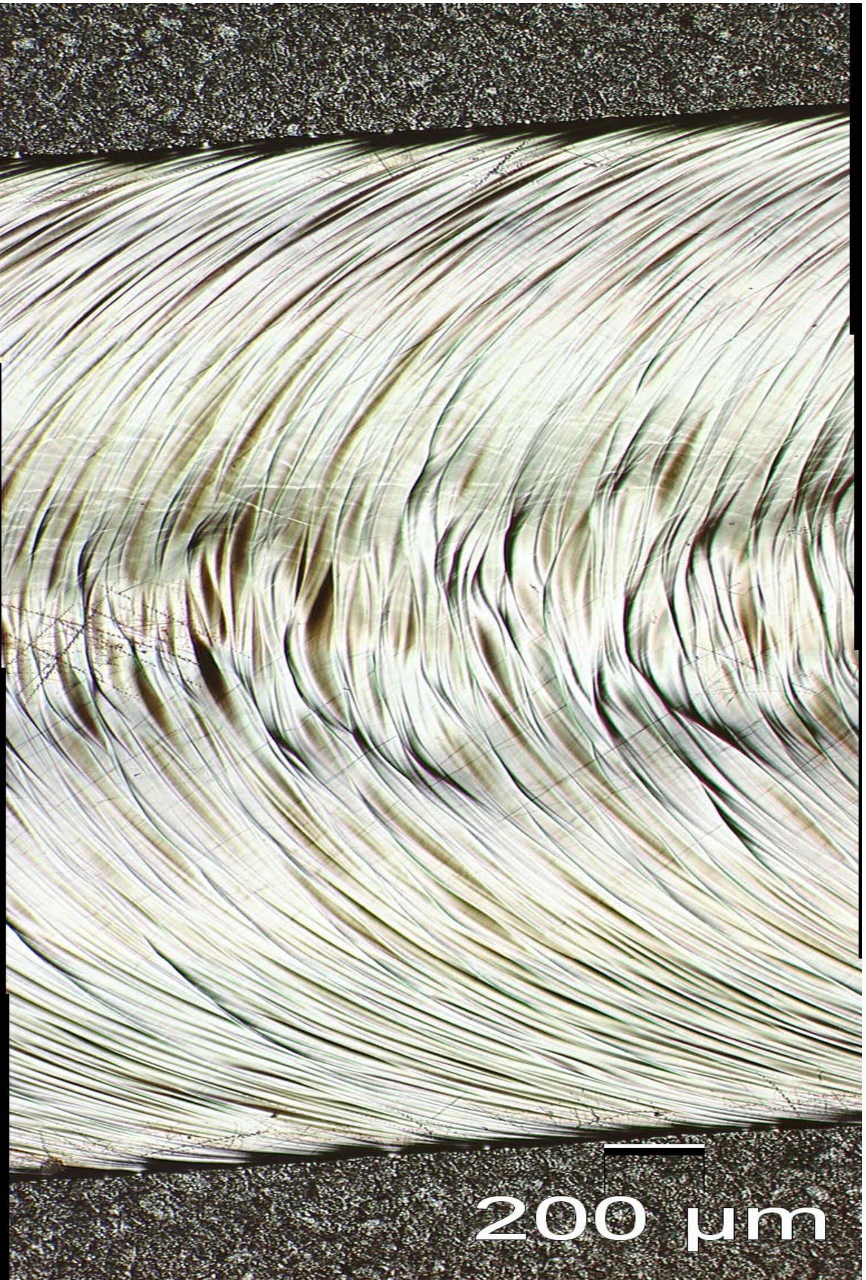


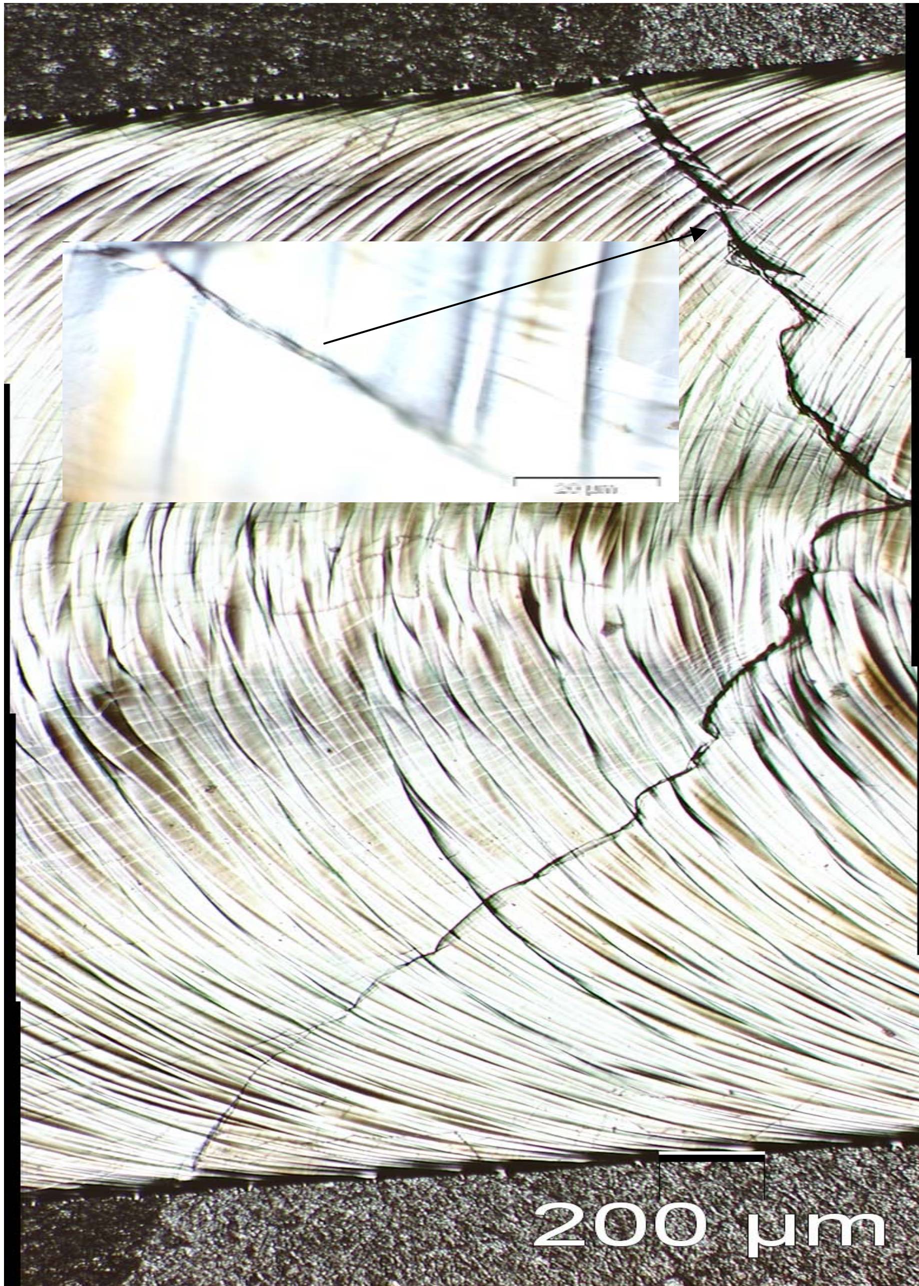


Ein großer Kristall

X. Singer

Korngrenze zwischen zwei Kristallen





Single Crystal Niobium Cavity (8)

Springback in Deep Drawn High Purity Niobium for Superconductor Cavities*

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Superconducting radio frequency (SRF) cavities made from deep drawn high purity niobium have become a popular approach for the design of particle accelerators. A number of current accelerators use this technology and it is a leading candidate for future designs. The development of this technology has required significant advances in many scientific fields including metallurgy, high vacuum physics, surface science, and forming. Recently proposed modifications to the current process for fabrication of these cavities has resulted in increased concern about the distribution of deformation, residual stress patterns, and springback. This presentation will report on the findings of a recently initiated program to study plastic flow and springback in the fabrication of these cavities and the influence of metallurgical variables including grain size and impurity content.

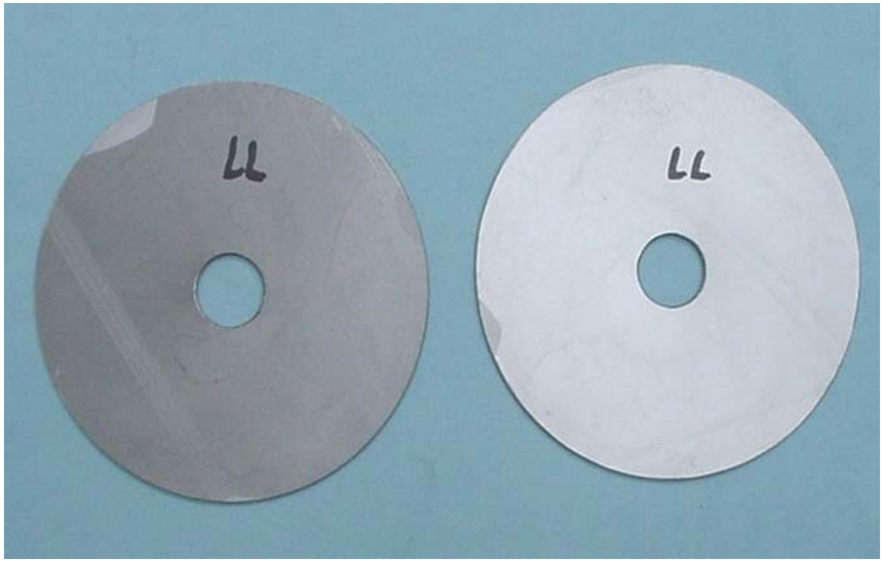
Single Crystal Niobium Cavity (9)

Nb Discs

LL cavity 2.3GHz

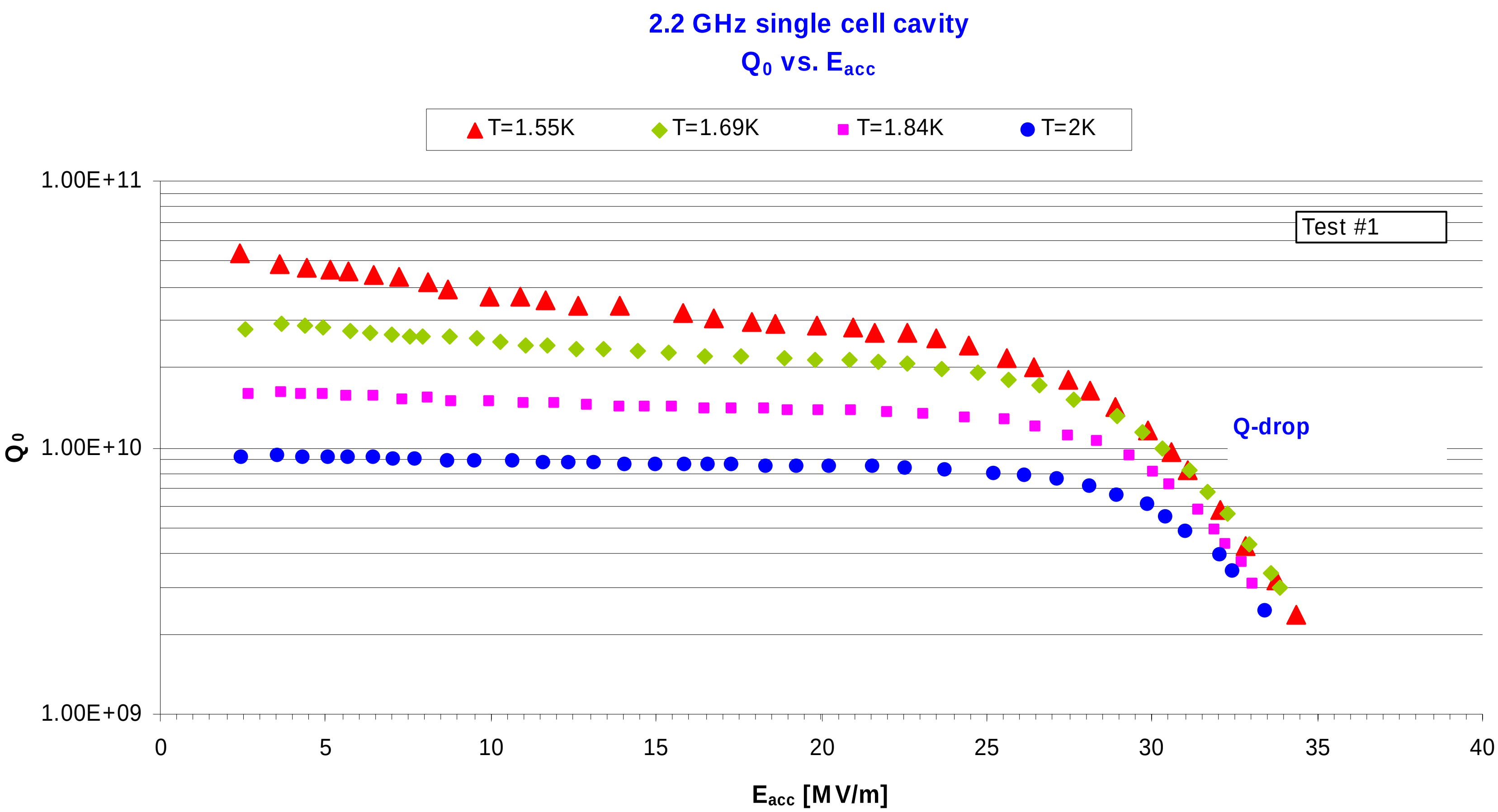
E_{peak}/E_{acc} = 2.072

H_{peak}/E_{acc} = 3.56 mT/MV/m



Standard Material: 2.2 GHz

Test #1:~ 100 mm bcp, 800C, 3 hrs,~ 80 mm bcp



Single Crystal Niobium Cavity (10)

Development Program

Material	Cavity/f [MHz]	Status	Results
Single crystal	HG, 2.2 GHz	tested	E_{acc} =38-43 MV/m R_{res} < 1 nΩ
standard	HG, 2.2 GHz	tested	E_{acc} ~35 MV/m R_{res} $\simeq$ 2 nΩ
Single Crystal	LL-ILC, 2.3 GHz	Fabricated, H-degassed	
Large Grain"A"	HG, 1.5 GHz	tested	E_{acc} =32 MV/m R_{res} ~ 7 nΩ
Large Grain"B"	HG, 1.5 GHz	tested	E_{acc} =30 MV/m R_{res} ~ 7 nΩ
Large Grain"A"	7-cell,HG, 1.5 GHz	In fabrication	
Single Crystal	7-cell,LL_ILC 1.3 GHz	Dies in fab Ingot in proc	
Large Grain"A"	HG, 1.5 GHz OC, 1.5 GHz	In fab, Saw cut	

Single Crystal Niobium Cavity (11)

What are the potential advantages of large grain/single crystal niobium?

- Reduced costs
- Comparable performance
- Very smooth surfaces with BCP
- Possibly elimination of "in situ" baking because of "Q-drop" onset at higher gradients
- Possibly very low residual resistances (high Q's), favoring lower operation temperature(B.Petersen)
- Good or better mechanical performance than fine grain material (e.g.predictable spring back..)