Current Status of Dielectric Test Cavity and Wafer Test Cavity

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TE_{01} cavities aimed at creating short sample RF measurements.

Allen et al. MAG-18 1983

f (GHz)	A_{Sample}	A_{rf}	$R_{sens}(\Omega)$	B_{max}
8.6	0.9 cm^2	0.9 cm^2	1 e-5	Very low

Kneisel et al. ASC 1986

f (GHz)	A_{Sample}	A_{rf}	$R_{sens}(\Omega)$	B_{max}
3.5	127 cm^2	127 cm^2	1 e-9	2 mT

Moffat, Rubin et al. 1988

f (GHz)	A_{Sample}	A_{rf}	$R_{sens}(\Omega)$	B_{max}
5.95	20 cm^2	0.2 cm^2	<1.5 e-5	?

Delaven. et al. J. Superconductivity. **3** 1990

f (GHz)	A_{Sample}	A_{rf}	$R_{sens}(\Omega)$	B_{max}
0.17 – 1.5	~1 cm^2	~1 cm^2	2e-6	64 mT

Liang, et al. RSI 1993

f (GHz)	A_{Sample}	A_{rf}	$R_{sens}(\Omega)$	B_{max}
1.5	4.9 cm^2	2.0 cm^2	1e-9	25 mT

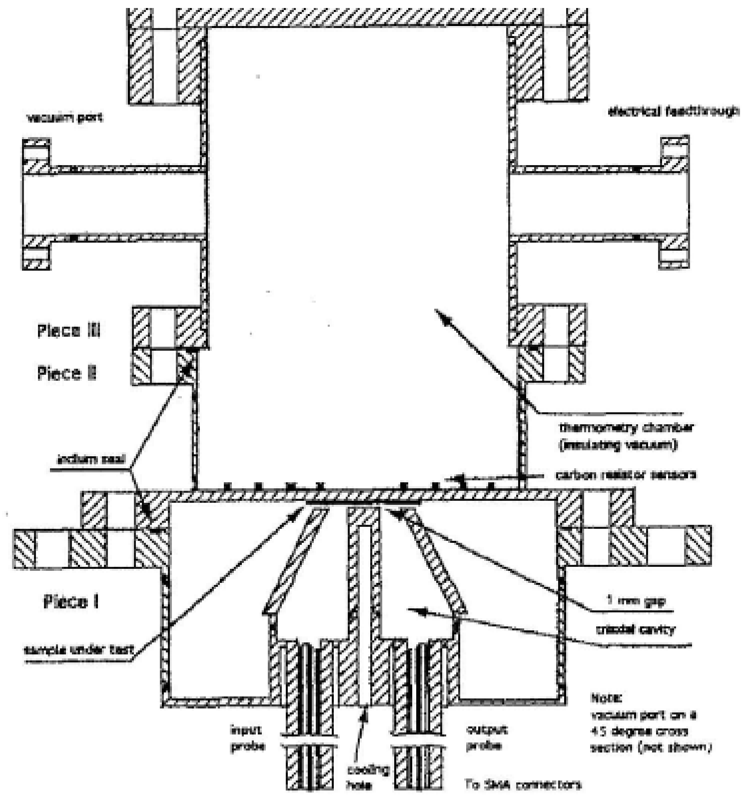


FIG. 1. The assembly consists of three pieces. Pieces I and II are made from reactor grade niobium, and Piece III from stainless steel. Vacuum port of the cavity is not shown.

More TE_{01} cavities aimed at creating short sample RF measurements

Mahner & Weingarten 8th SRF 1997

f (GHz)	A_{Sample}	A_{rf}	$R_{sens}(\Omega)$	B_{max}
1.5	12 cm^2	2 cm^2	1e-6	60 mT

Andreone, et al. SRF Thin Film Wkshp 2006

f (GHz)	A_{Sample}	A_{rf}	$R_{sens}(\Omega)$	B_{max}
7	1 cm^2	1 cm^2	1e-5	0.15 mT

Mahner, Haebel, et al. CERN RSI 2003

f (GHz)	A_{Sample}	A_{rf}	$R_{sens}(\Omega)$	B_{max}
0.403	44 cm^2	12 cm^2	1e-9	0.15 mT

Nantista SLAC PAC 2005

f (GHz)	A_{Sample}	A_{rf}	$R_{sens}(\Omega)$	B_{max}
11.4	19.6 cm^2	~8 cm^2	?	?

Delayen, Wang, Phillips

f (GHz)	A_{Sample}	A_{rf}	$R_{sens}(\Omega)$	B_{max}
7.5	20 cm^2	**0.8** cm^2	<1e-7	?

Romanenko Cornell SRF Wkshp 2005

f (GHz)	A_{Sample}	A_{rf}	$R_{sens}(\Omega)$	B_{max} (mT)
5.95	35 cm^2	35 cm^2	2e-6	45

Martens APL 1991

f (GHz)	A_{Sample}	A_{rf}	$R_{sens}(\Omega)$	B_{max} (mT)
34	35 cm^2	12 cm^2	2e-3	?

Oates, Moeckly ASC 2006

f (GHz)	A_{Sample}	A_{rf}	$R_{sens}(\Omega)$	B_{max} (mT)
0.6 × n to 10	<0.1 cm^2	<0.1 cm^2	< 1 e-7	?

Taber RSI 1990

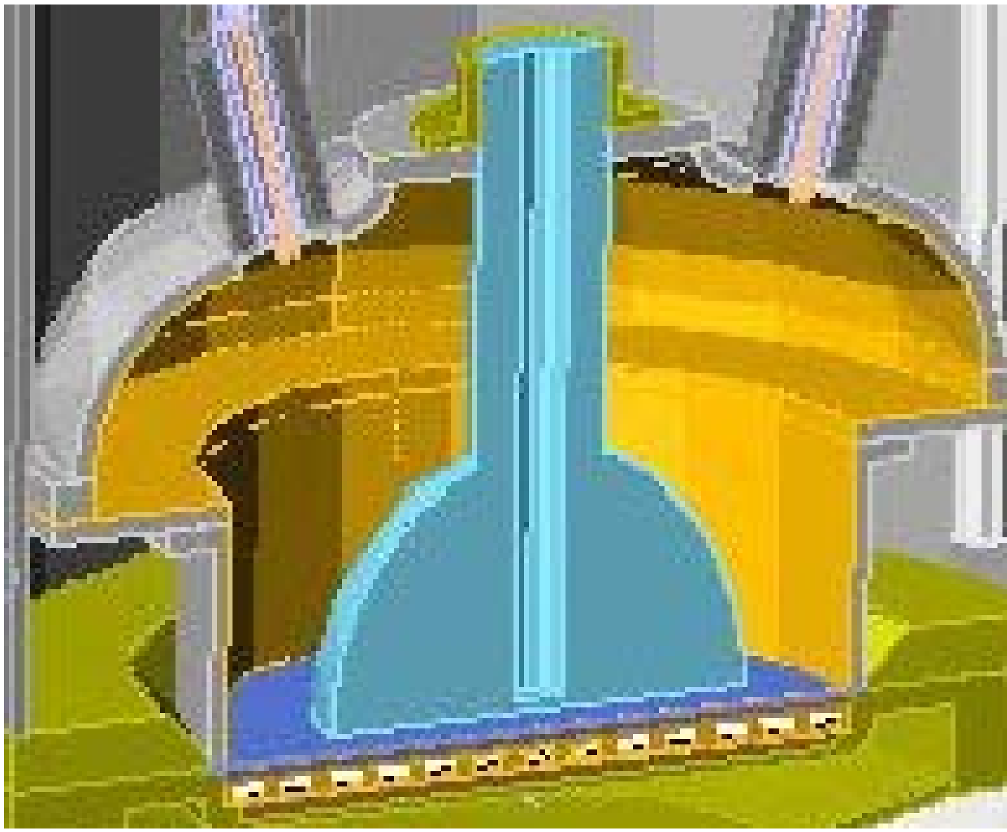
f (GHz)	A_{Sample}	A_{rf}	$R_{sens}(\Omega)$	B_{max} (mT)
10	1 cm^2	1 cm^2	1e-5	?

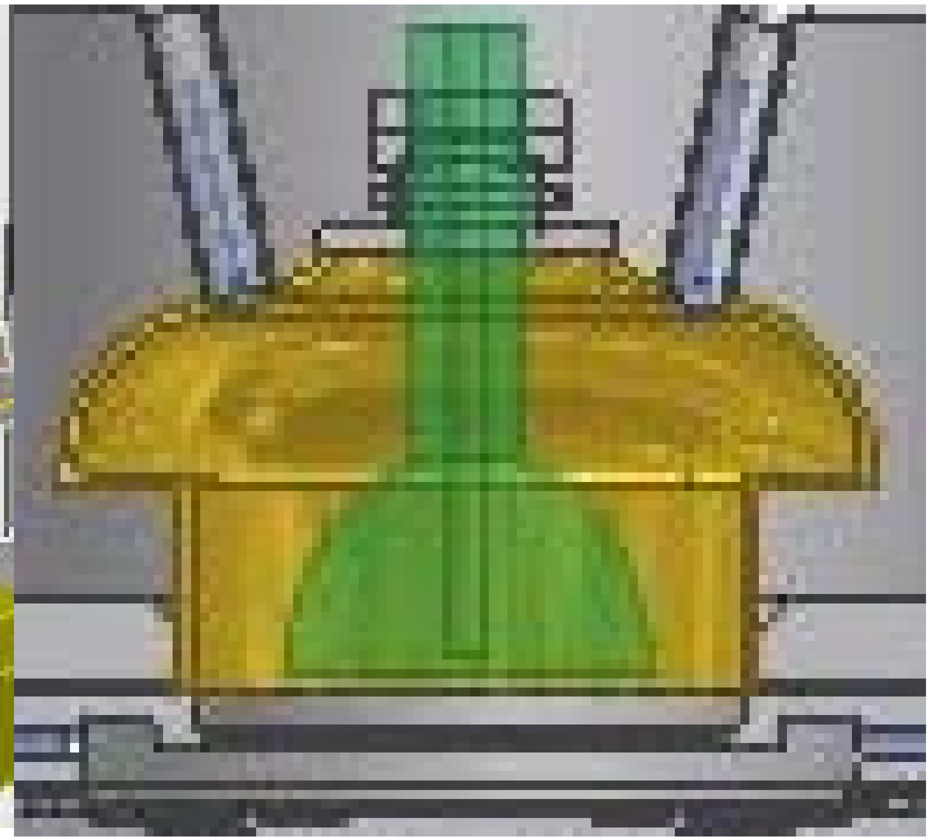
Ciovati, Kneisel JLab

f (GHz)	A_{Sample}	A_{rf}	$R_{sens}(\Omega)$	B_{max} (mT)
3.54	22 cm^2	18 cm^2	?	50

No robust solution is yet in hand, but the chase continues .. - Charlie Reece SRFM 07

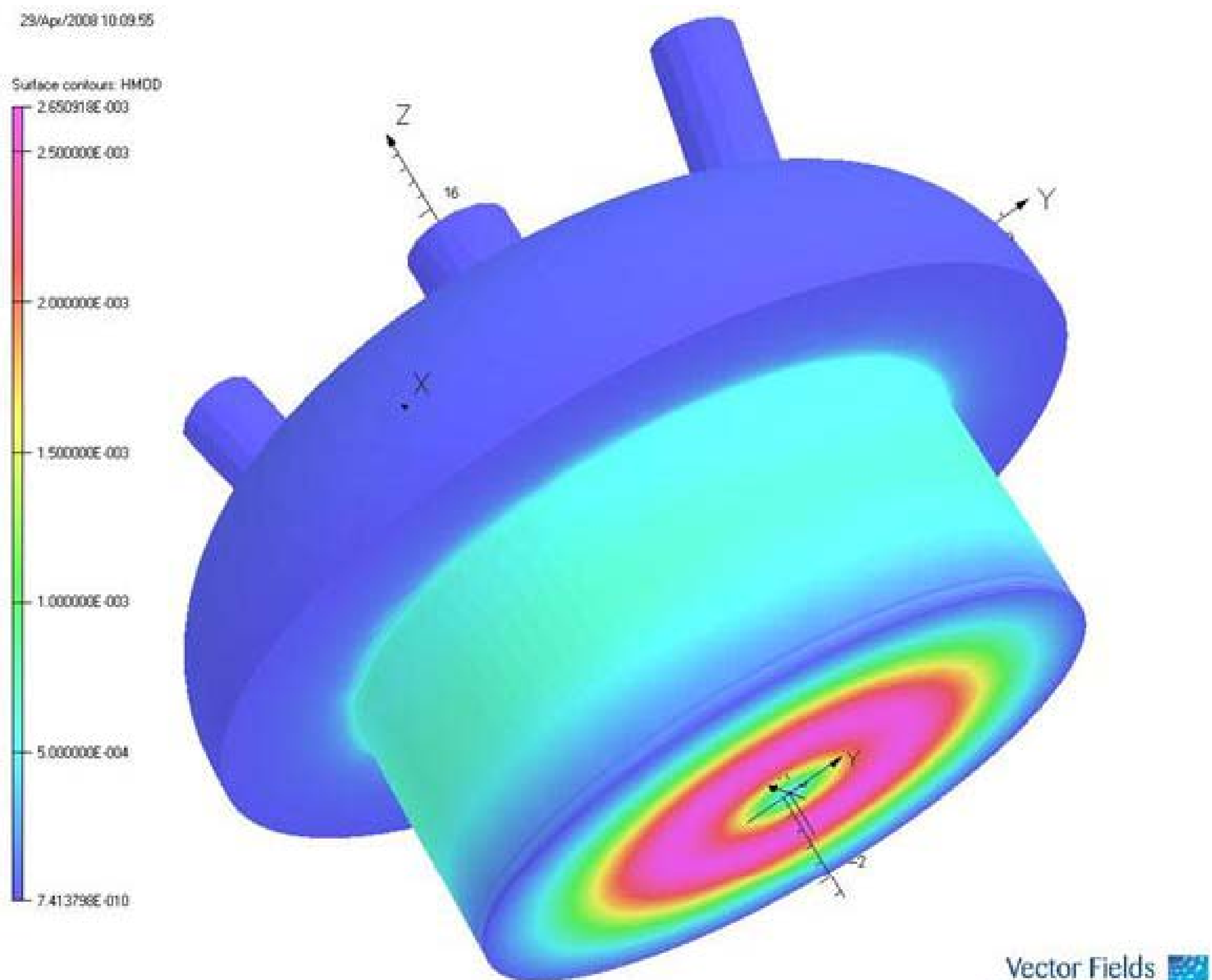
Our solution



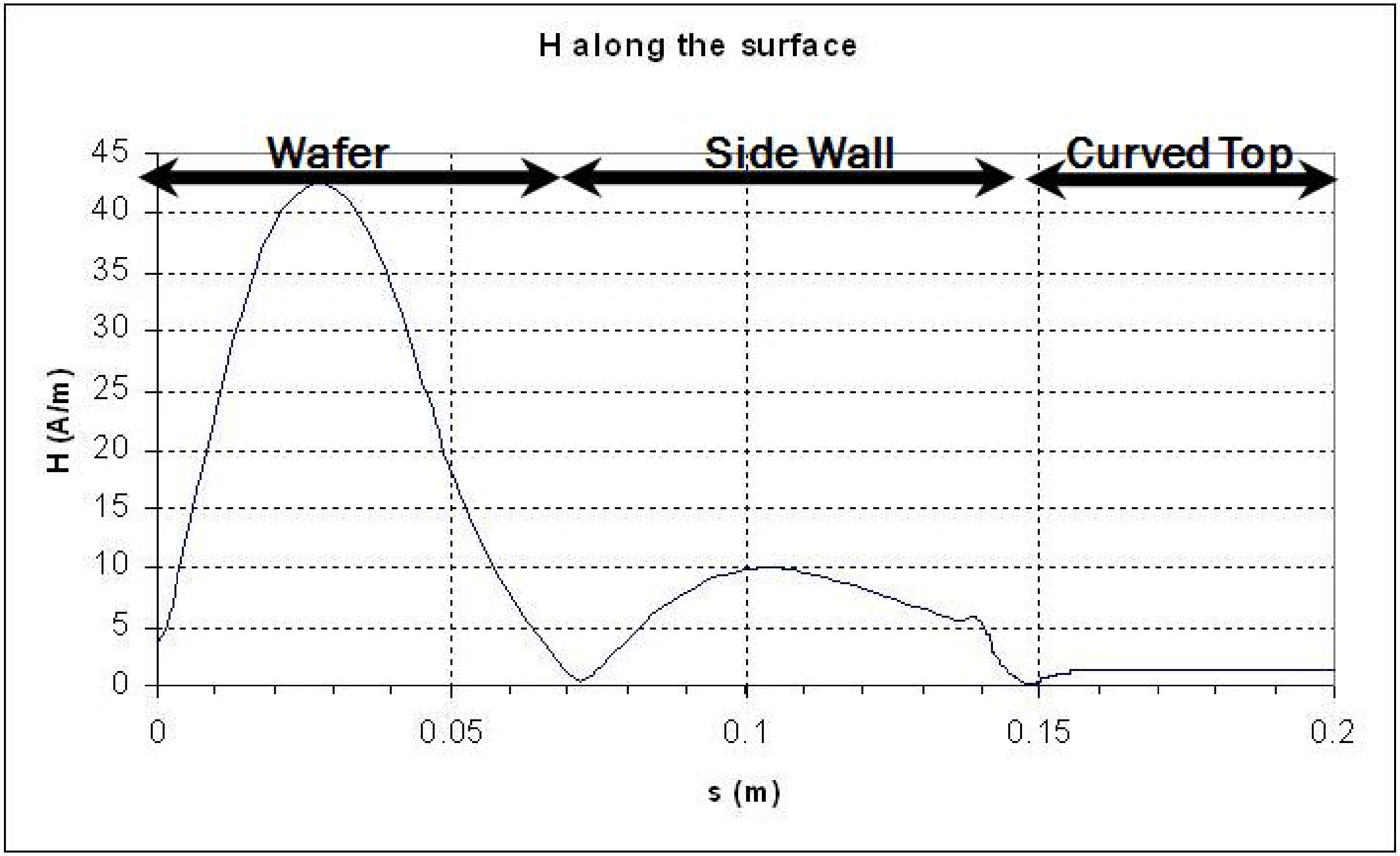


f (GHz)	A_{Sample}	A_{rf}	$R_{\mathrm{sens}}(\Omega)$	B_{max}
1.3	182 cm^2	163 cm^2	10^{-9}	>200 mT

Field Design: H-field Modulus

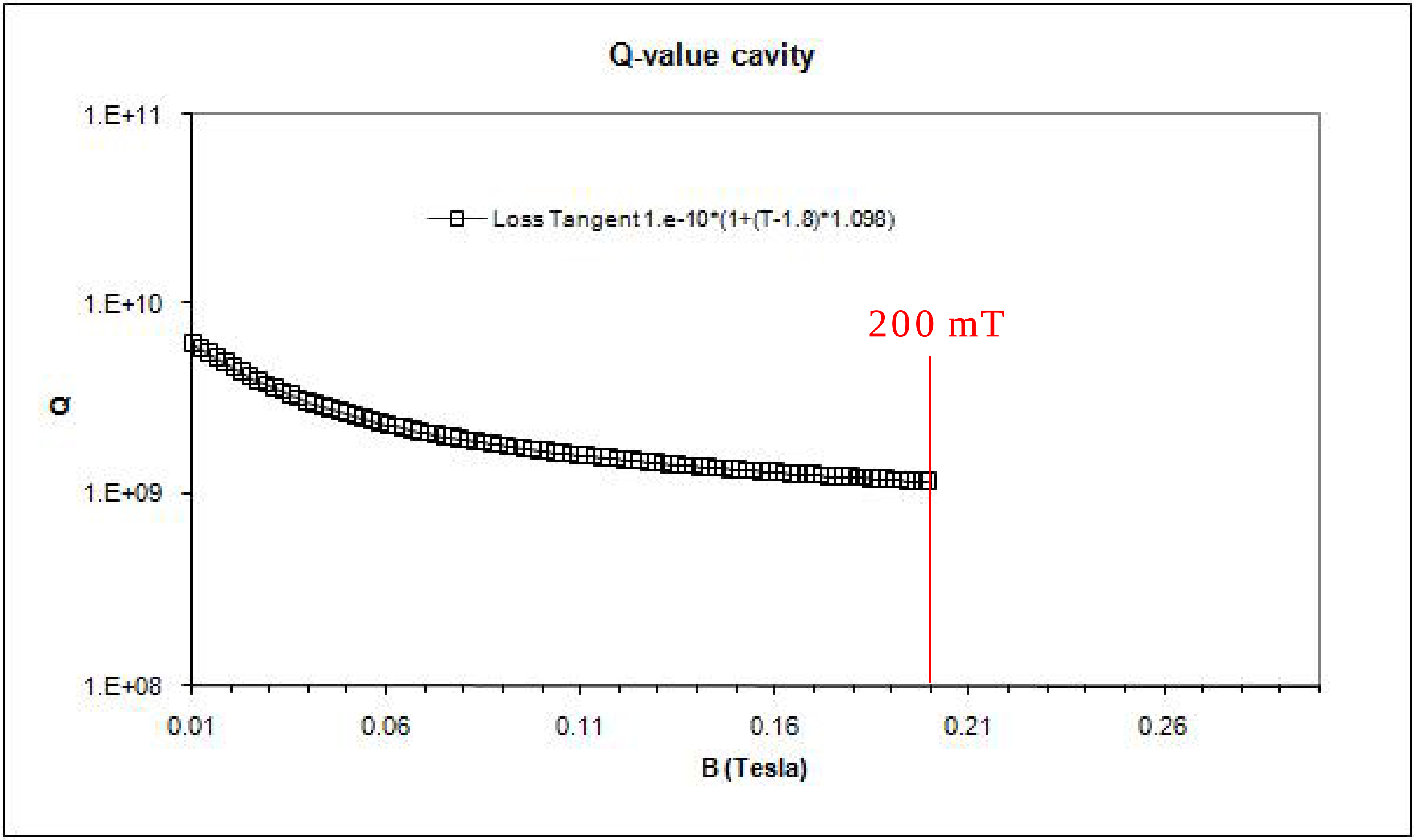


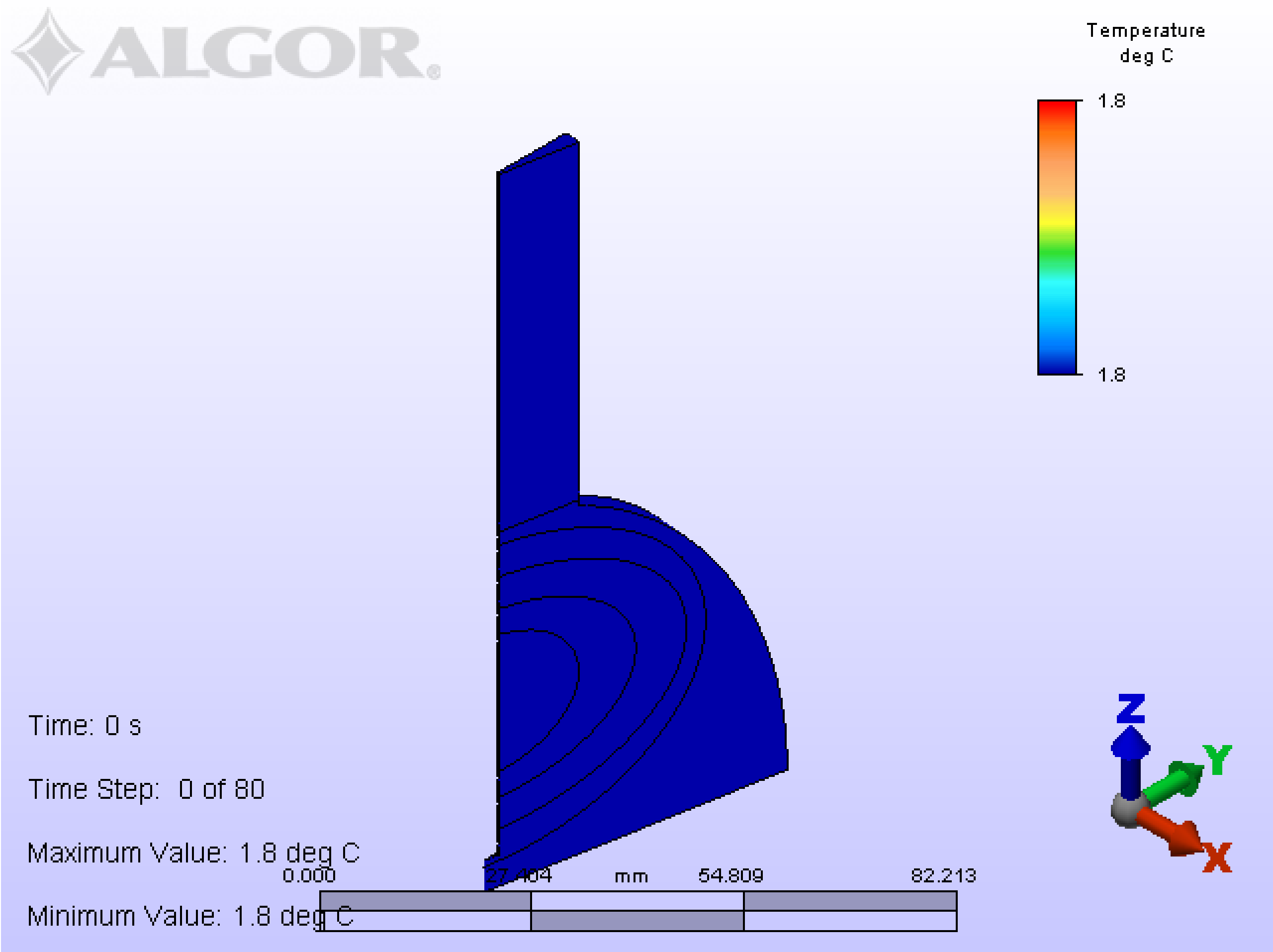
Field Profile



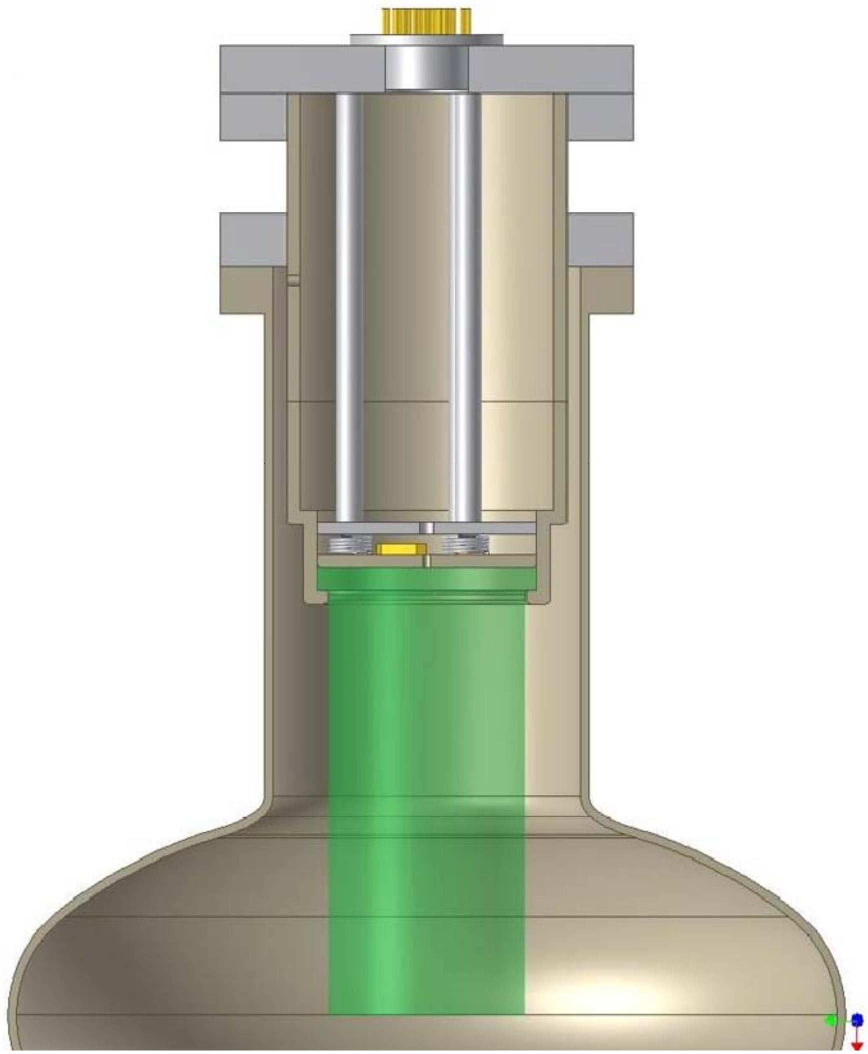
Four times the field on the sample than on the cavity walls.

Properties: Q-Value vs. H Field




ALGOR
Temperature
deg C
1.8
1.8
Time: 0 s
Time Step: 0 of 80
Maximum Value: 1.8 deg C
Minimum Value: 1.8 deg C
0.000
27.404
mm
54.809
82.213
Z
Y
X

Sapphire Test Cavity



Components

Side Port

Sapphire

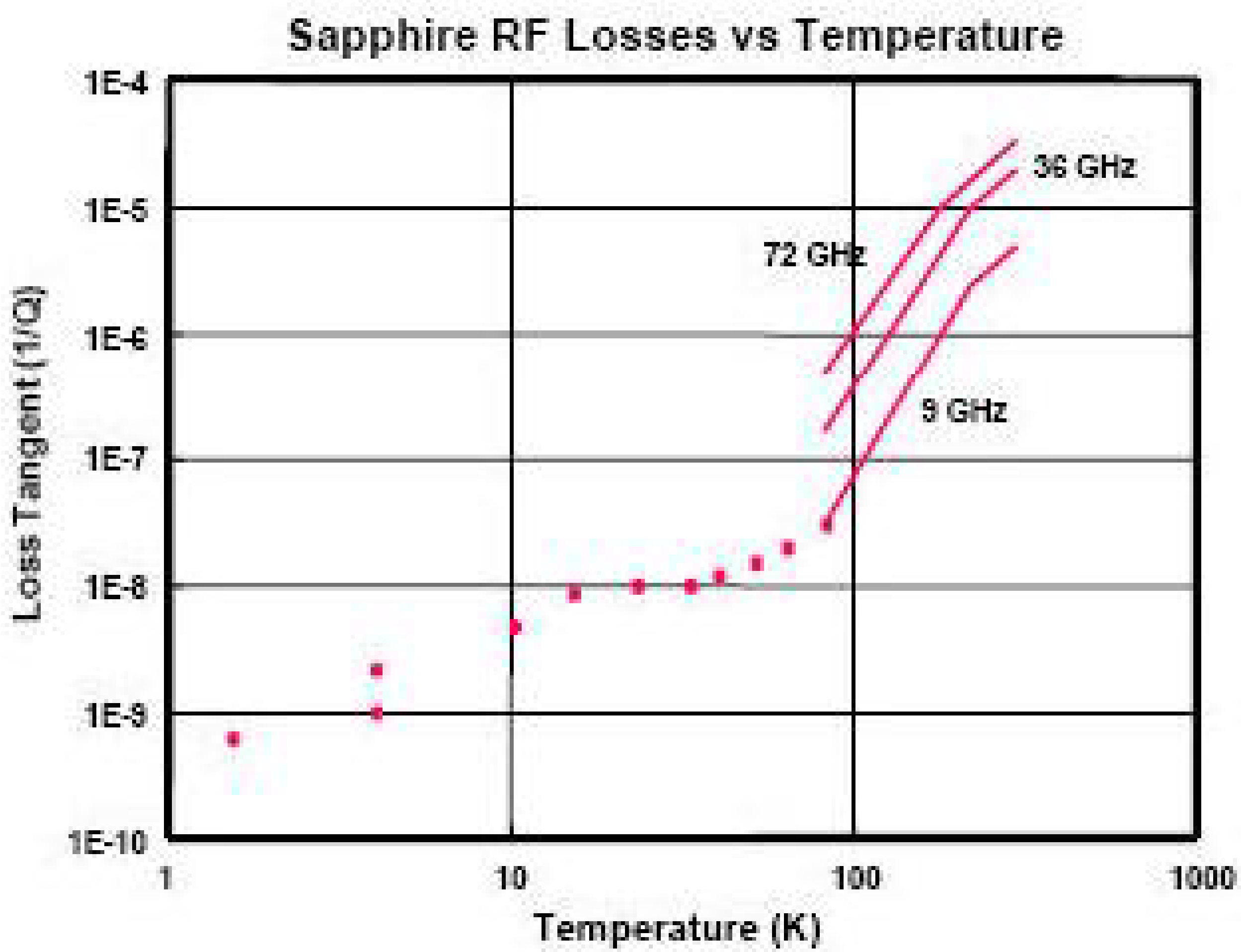
Sapphire is 10.20 cm tall
Outer Diameter 5 cm
Inner diameter 4.5cm

Sapphire for indium seal test

Half cells

Beam Tube

Goals



Sapphire RF Losses vs Temperature
Loss Tangent (1/Q)
1E-4
1E-5
1E-6
1E-7
1E-8
1E-9
1E-10
1
10
100
1000
Temperature (K)
36 GHz
72 GHz
9 GHz

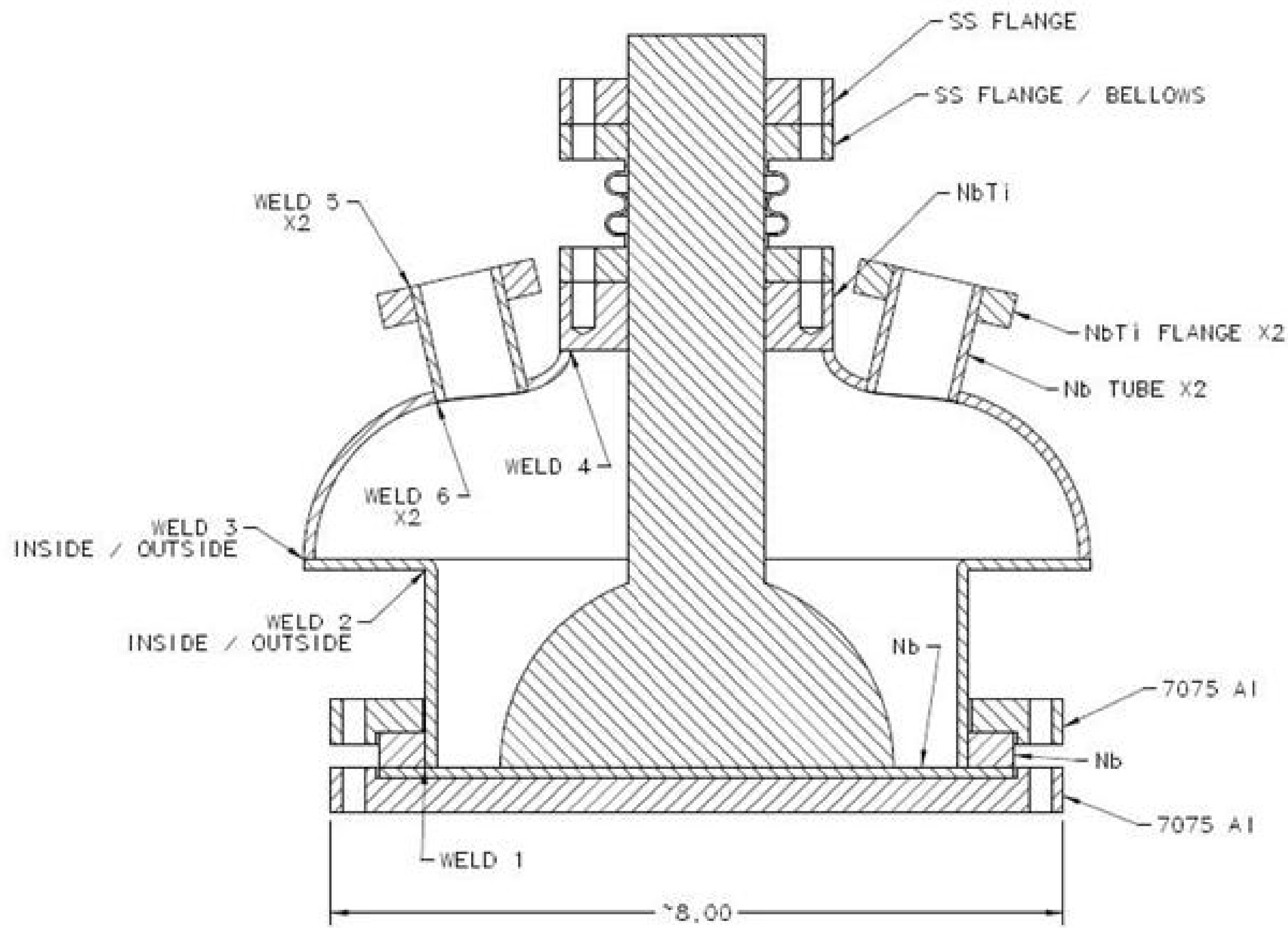
start losstan	1.00E-07	1.00E-08	1.00E-09	1.00E-10	1.00E-11
T					
2	99.999	99.995	99.946	99.463	94.874
4	99.995	99.951	99.508	95.285	66.897
9	99.991	99.914	99.148	92.085	53.775
10	88.304	43.021	7.02	0.749	0.075
ratio sapp/total		in percent			

Taking into account the superconducting transition of indium (over estimated) and niobium. It also takes into account the temperature dependence of niobium's resistance.

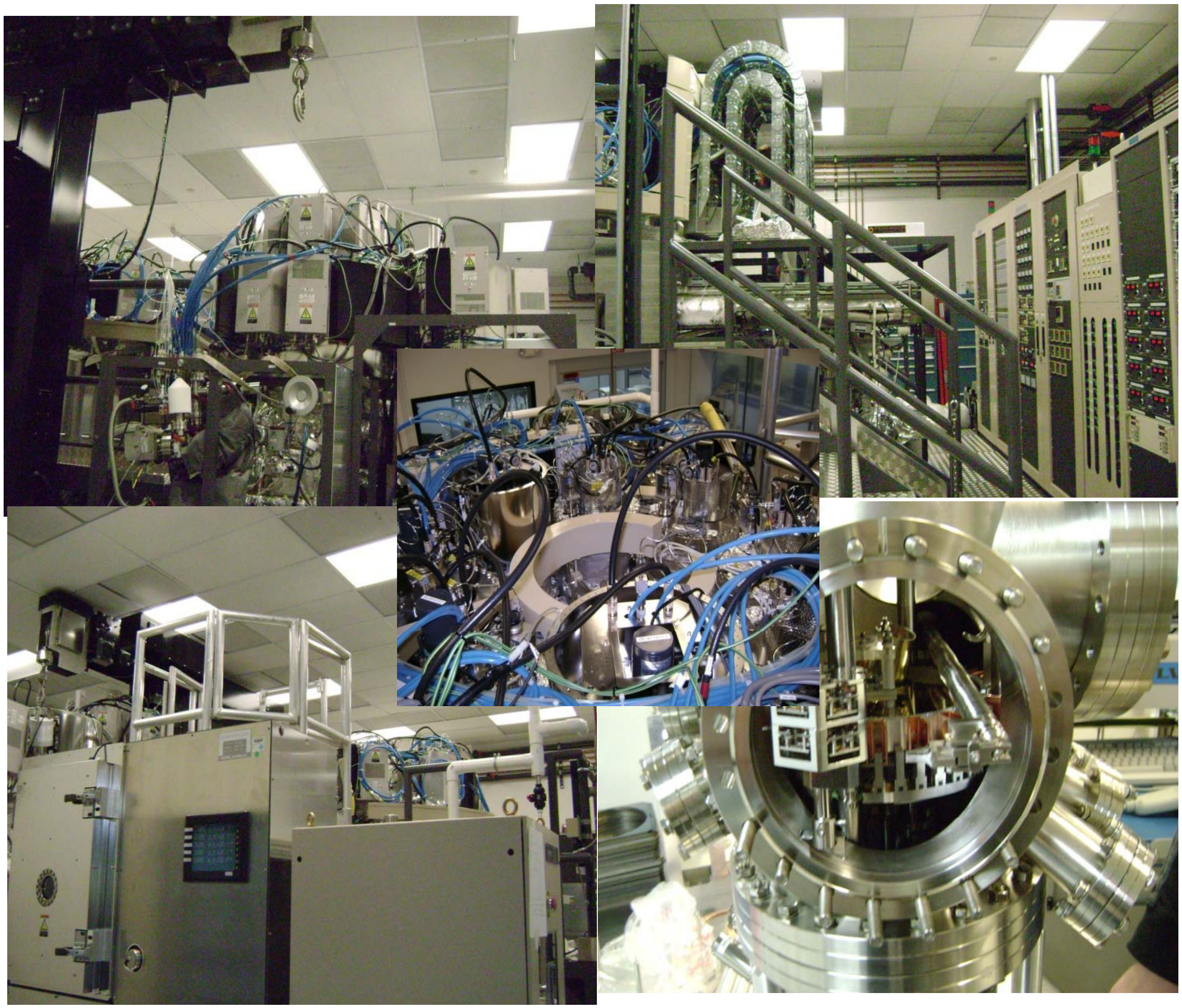
Different frequencies

Different materials

Wafer Cavity



ULVAC



Projected Schedule

Date	Milestone	Outcome	Comp. Date
10/09	Initiate mechanical and electromagnetic design of system for loss tangent measurement of large sapphire dielectric	Measurement of loss tangent of HEMEX sapphire at L-band frequencies	05/10
12/10	Initiate fabrication of Test Cavity per TAMU design	TAMU Test Cavity ready for initial testing	05/11
05/11	Begin commissioning Test Cavity with TAMU staff	TAMU Test Cavity functional for material characterization	12/11
02/12	Begin characterization of 6” samples using Test Cavity	High-H-field characterization of SRF sample surfaces	09/12