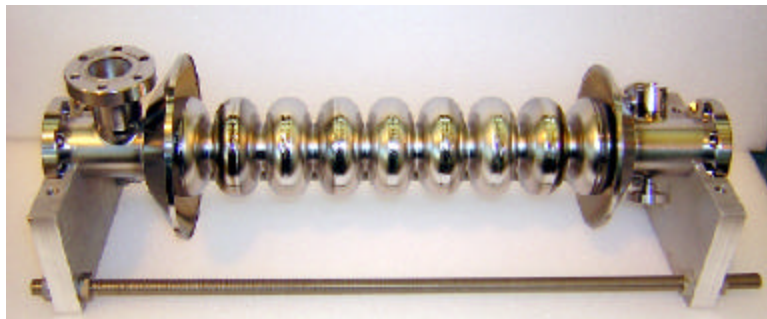
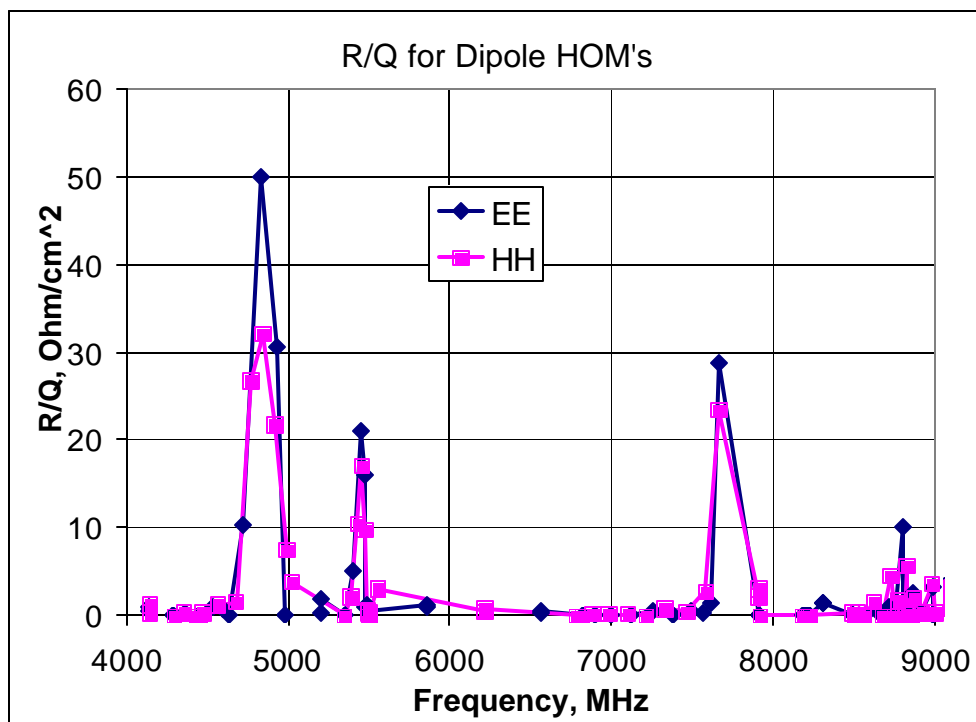


New 3.9 GHz HOM couplers at FNAL.

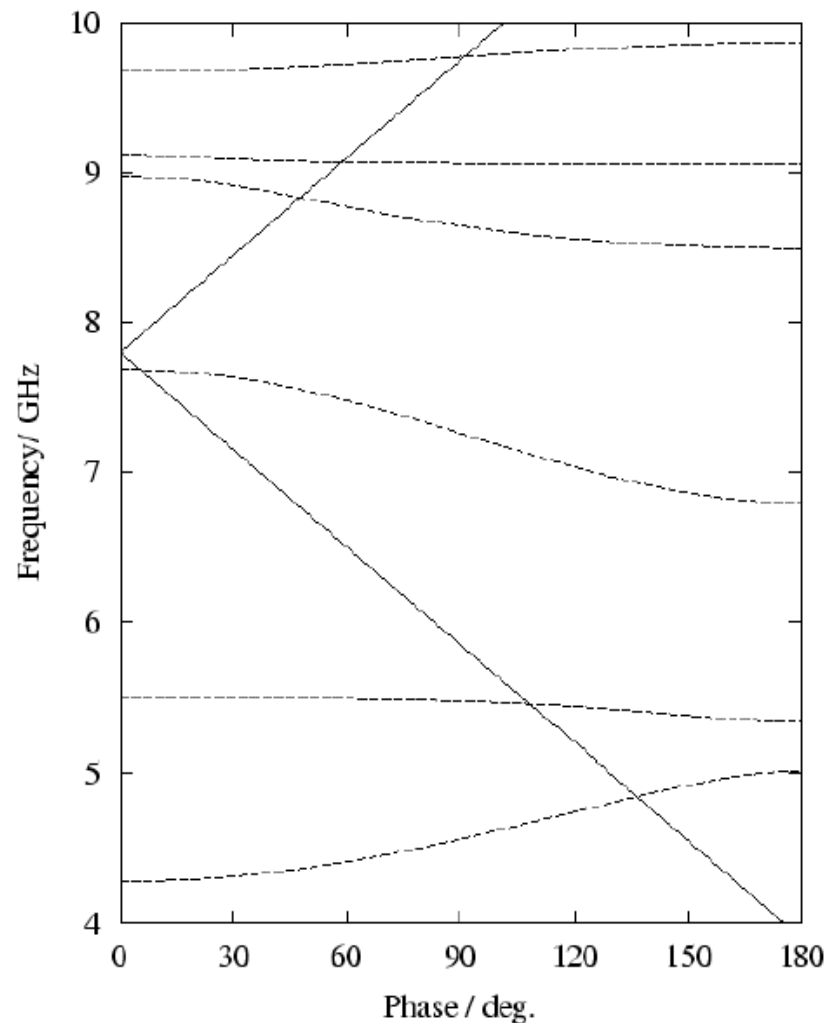


9 cell 3rd Harmonic Cavity with 2 HOM couplers.



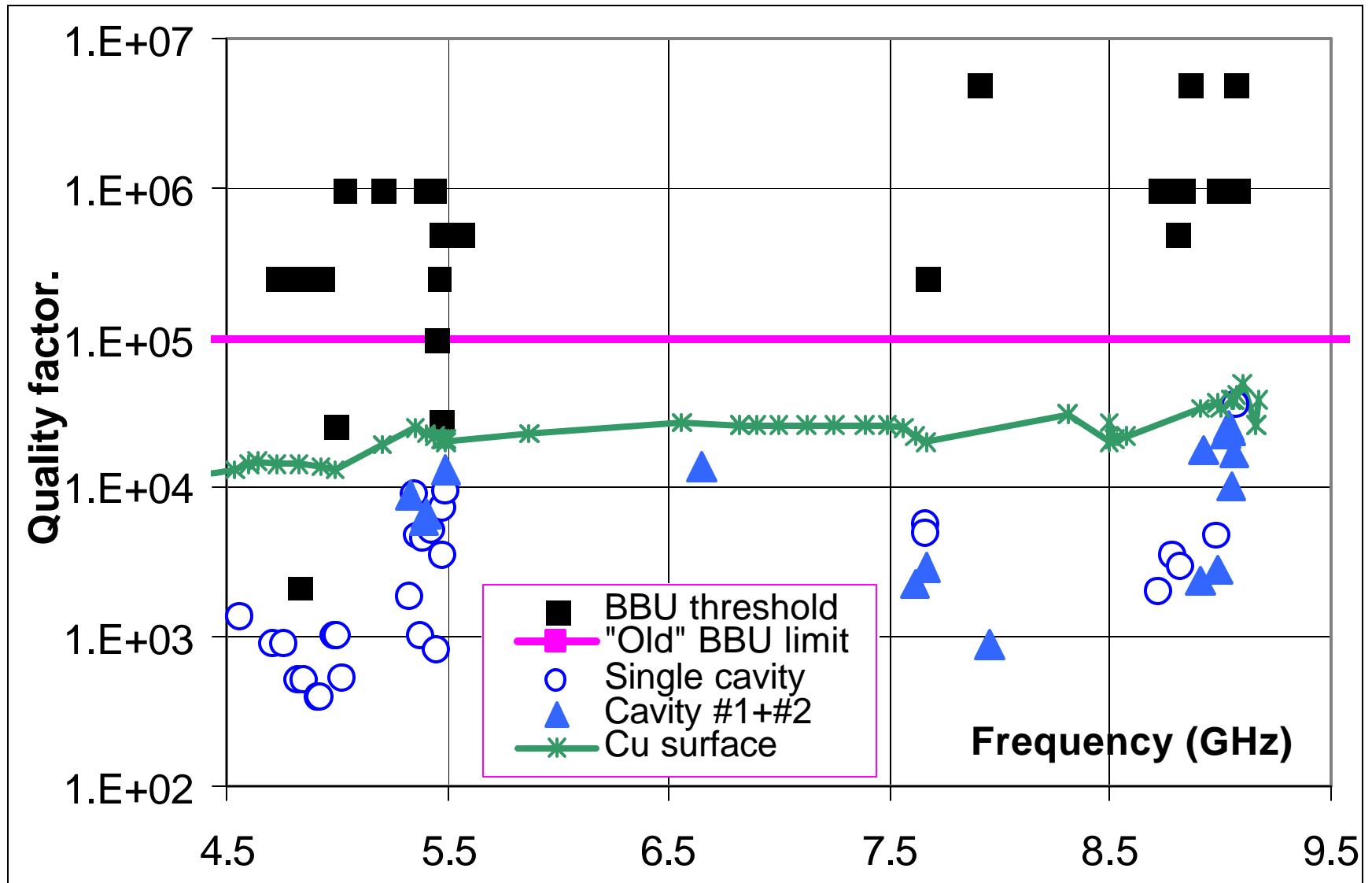
Calculated R/Q of the 9 cell 3rd Harmonic Cavity.

Cavity design.

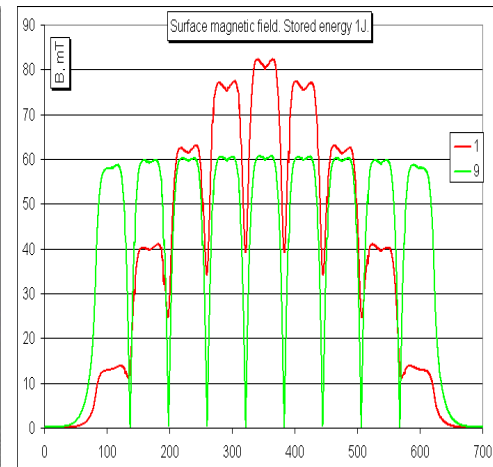
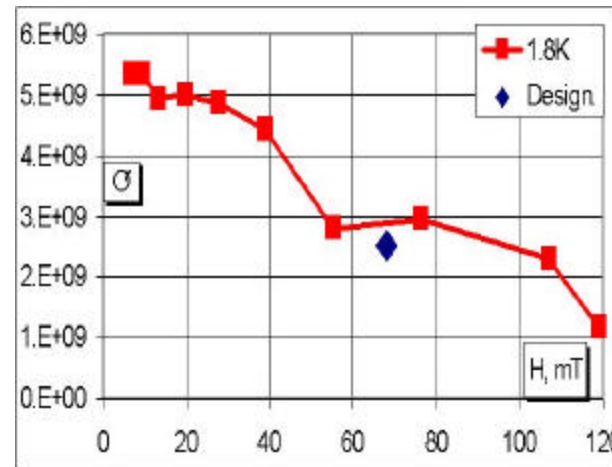
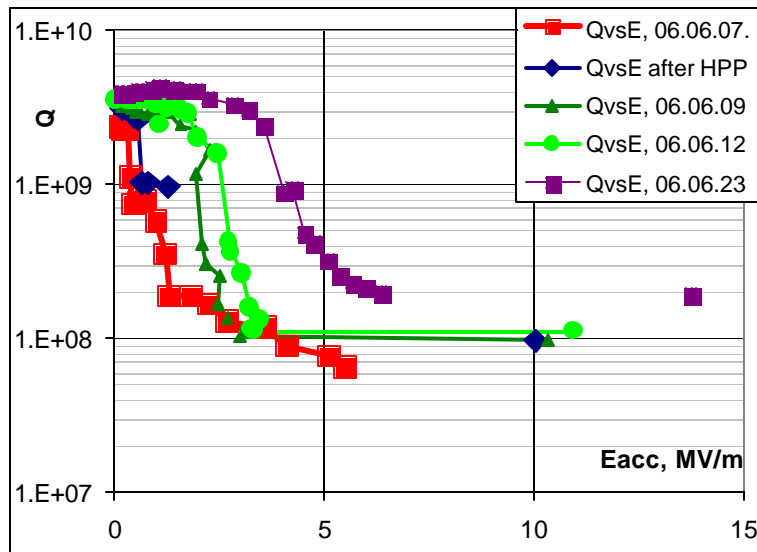


5 dipole pass bands of the 3rd Harmonic Cavity.

Calculated and measured Q of the 9 cell cavity.

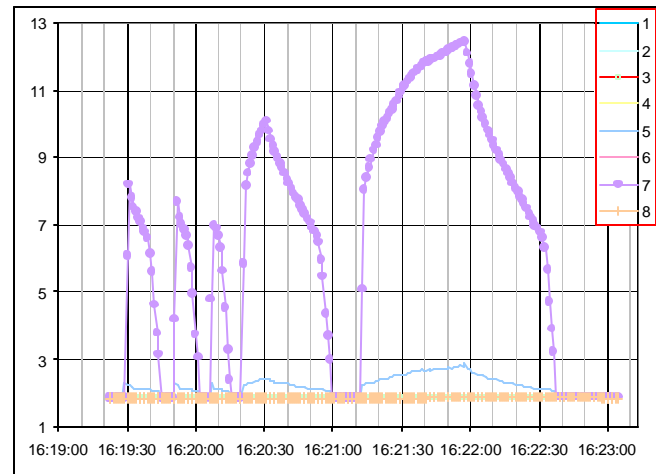
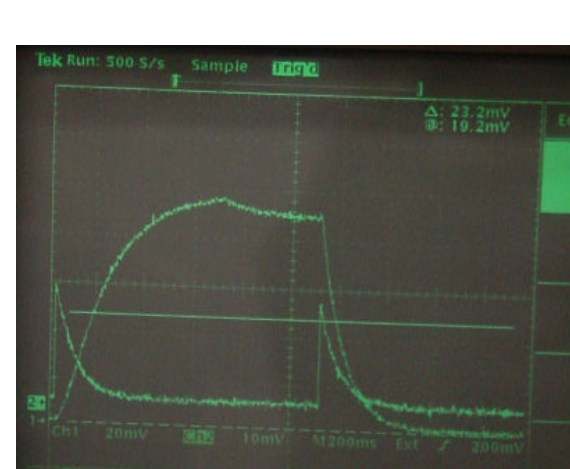


Problems with HOMs during vertical test of the 2nd cavity.

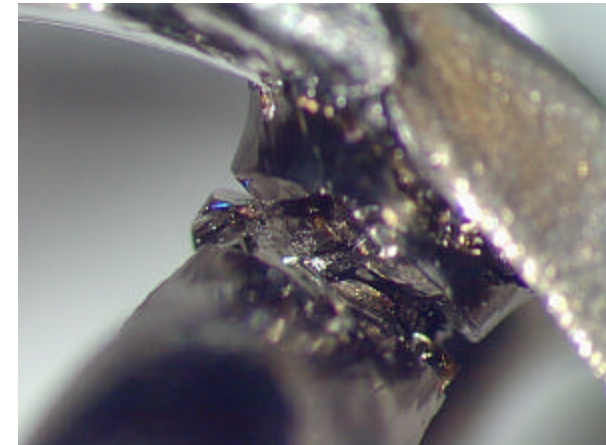


Surface magnetic field in "0"-mode.

QvsE measurements in "Pi"-mode.



Temperature sensors installed in the HOM shows heating.



Both HOMs coupler fractured after high power vertical tests.

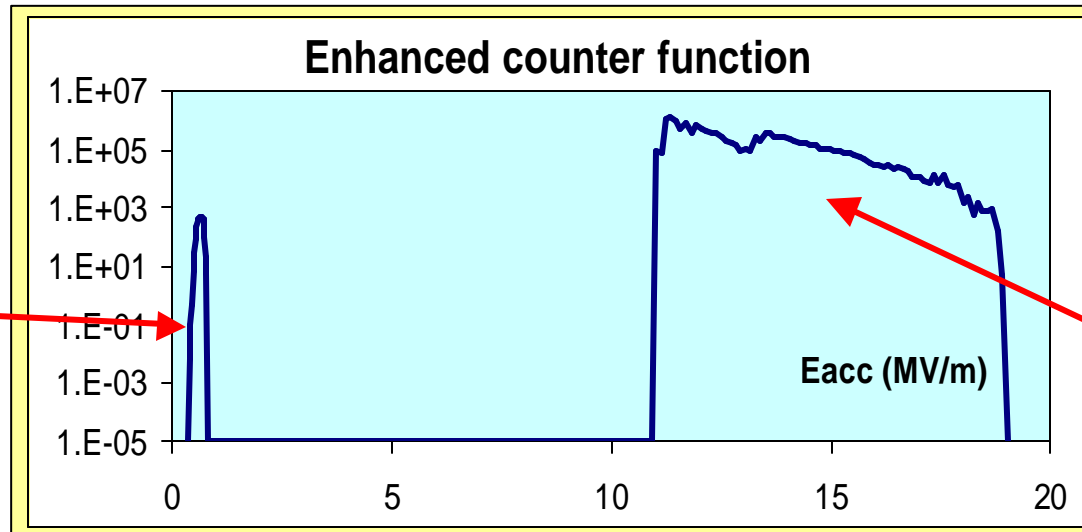
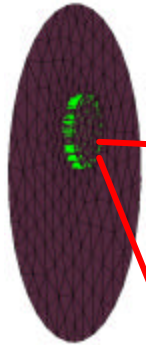
"Multipactor". Transmitted and reflected power.

MP in old (first) HOM design

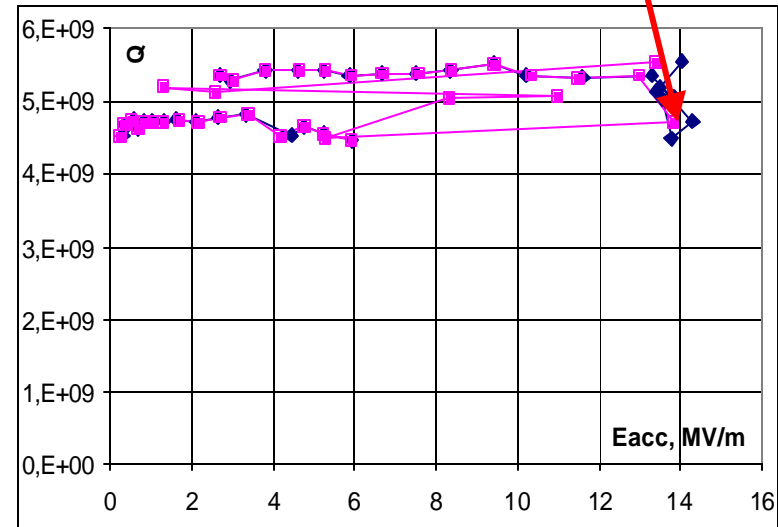
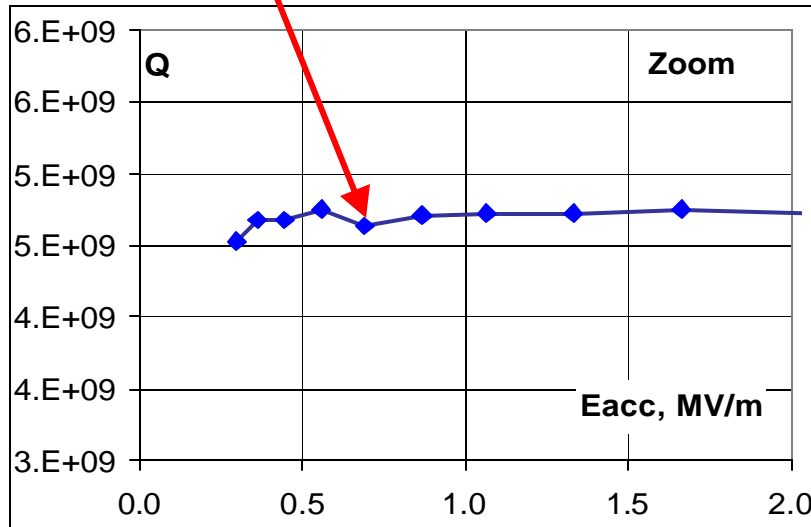
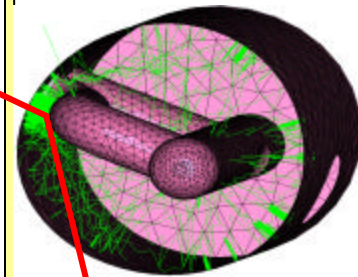
3D simulation

Omega 3P(Analyst)

MP in
notch gap
0.6 mm

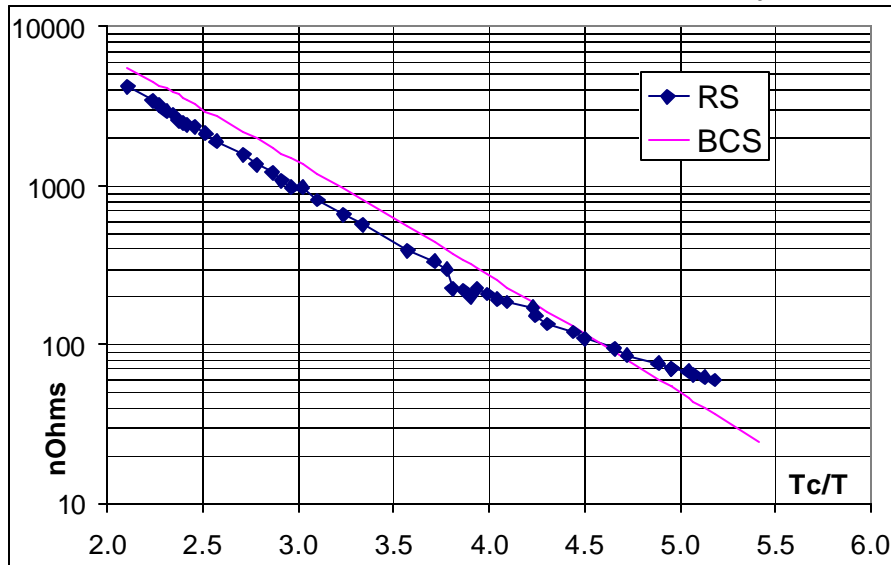


MP in 2 mm
Leg-wall gap

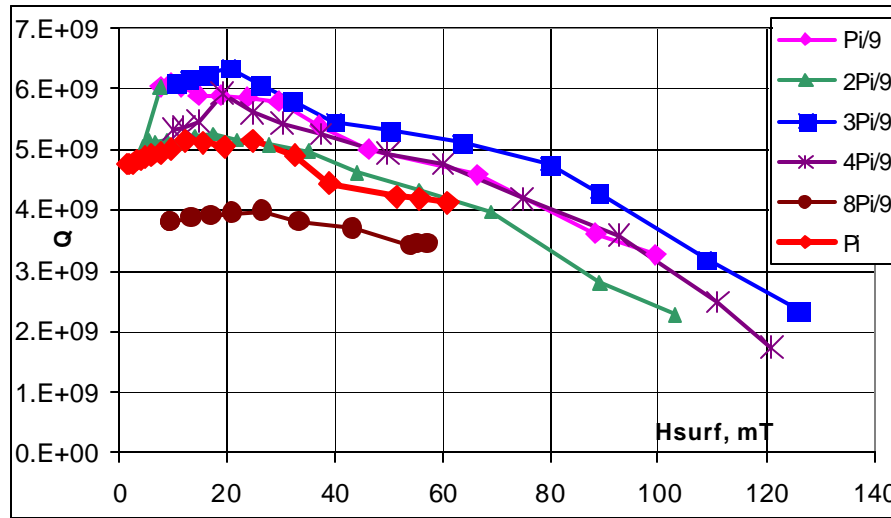


Cavity No.3. Results of vertical test#2: MP observed at $E_{acc} \sim 0.7$ MV/m (Q drop). Quench at $E_{acc} \sim 14$ MV/m. Second resonance frequency of HOM was tuned higher than designed value.

3rd Nb9cell cavity 4th cold test. F=3899.46 MHz.

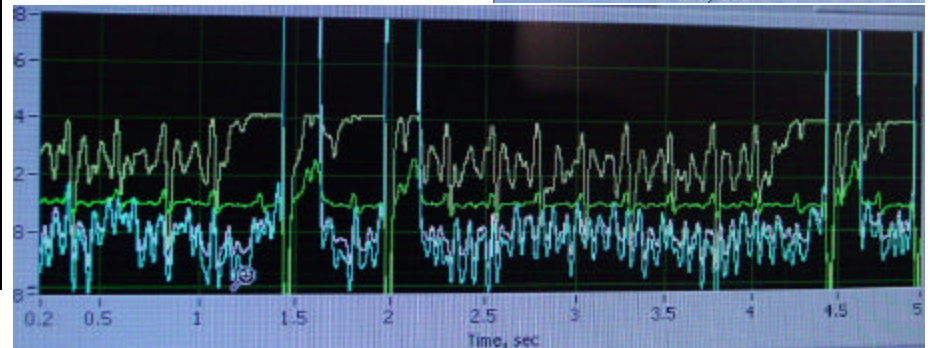
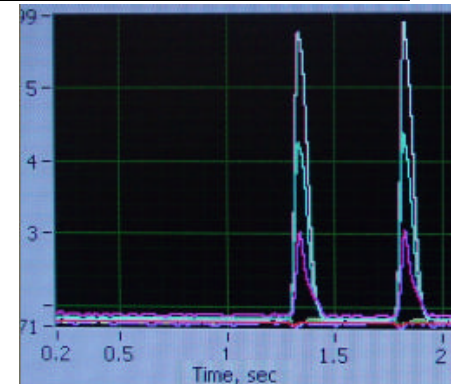
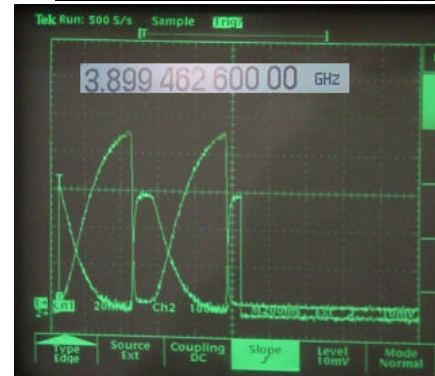
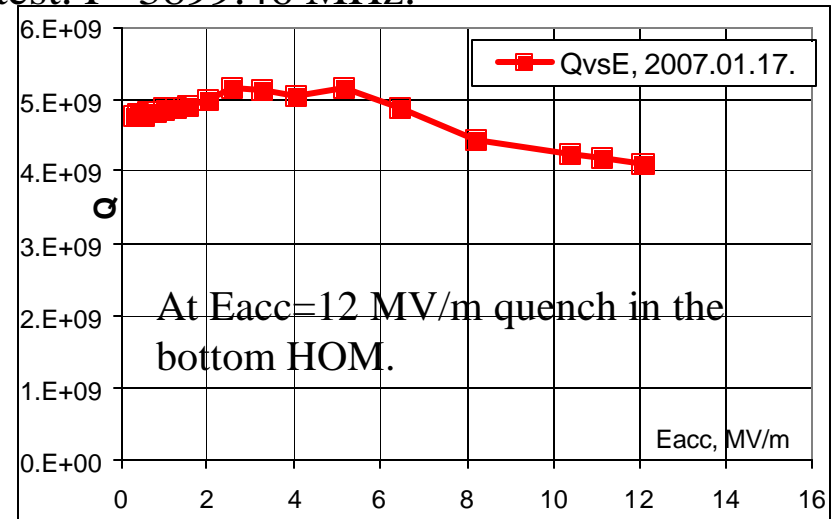


Q vs T at Pi-mode. F=3899.46 MHz. Cavity baked 150C 48 h. R_{res}=25 nOhms.



Q vs. max. surface H-field for some modes.

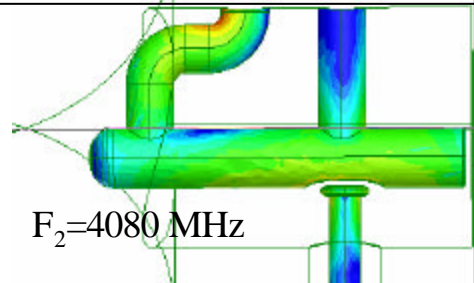
Quench in HOM for Pi and 8/9Pi modes and in the cavity cells for lower modes.



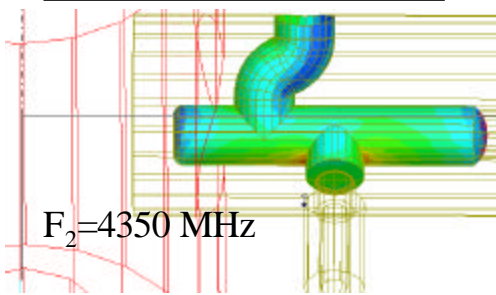
T-sensor between welds of the bottom HOM go up to maximum 6 K. RF fall time 20 msec.

Designs of the HOM coupler

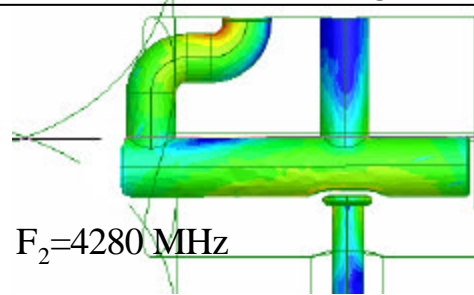
Initial design No.1



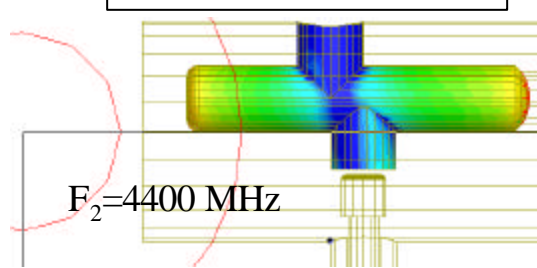
1-post design #3



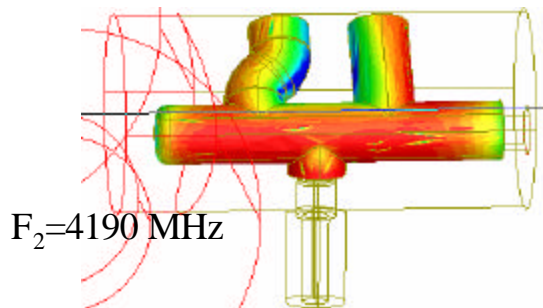
Trimmed Initial design -1a



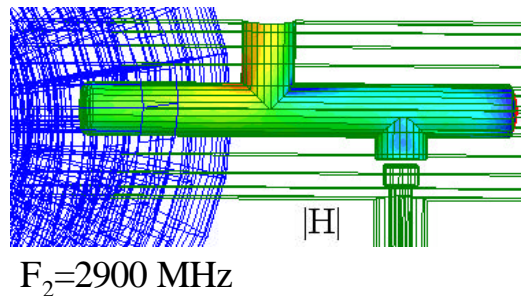
1-post design #4



Modified 2-post design #2

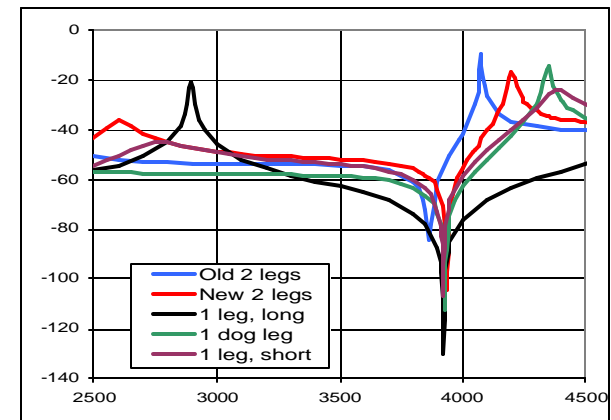


1-post Long design #5

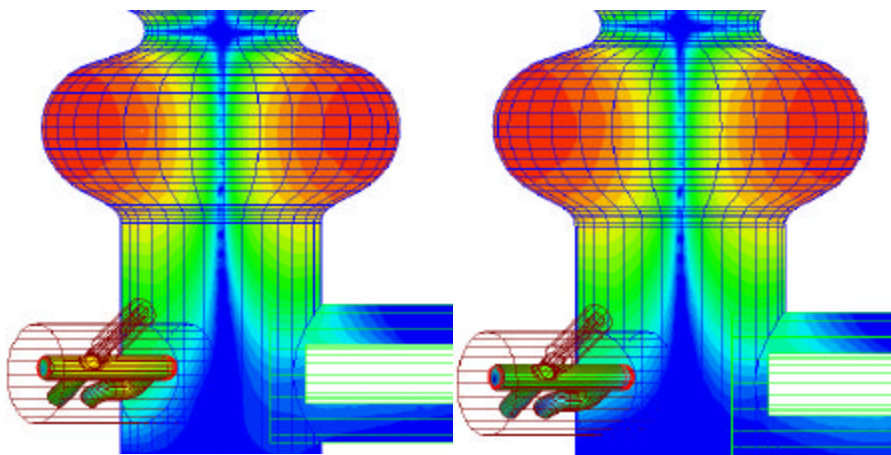


HOM Comparison

	$H_p/H\#1$	$E_p/E\#1$
HOM #1	1	1
HOM #1a	0.4	0.4
HOM #2	0.76	0.45
HOM #3	0.77	0.48
HOM #4	0.67	0.31
HOM #5	0.57	0.098
cavity	7.4	3.5



HOM Damping properties for modified coupler design.



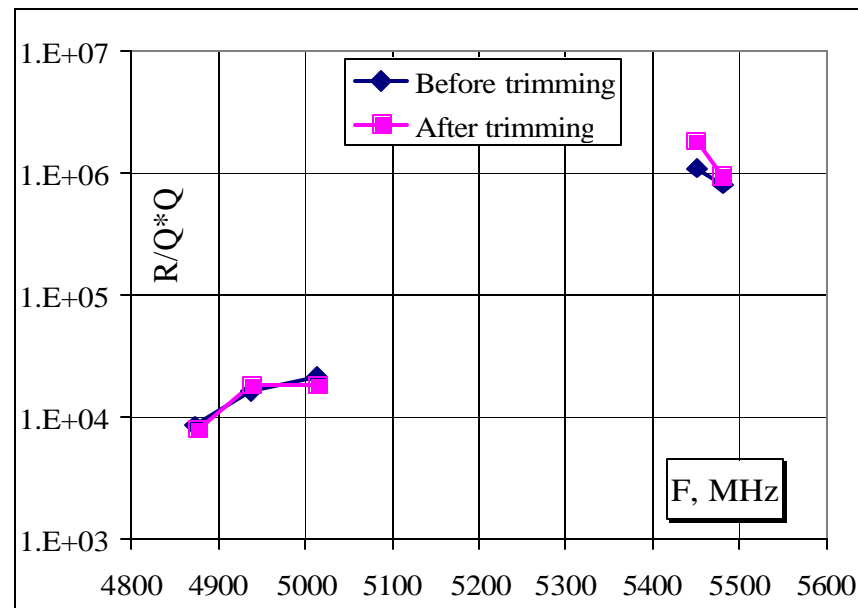
Old design

Old HOM with trimmed antenna

Magnetic field on the surface of the HOM form tile dropped 2.5 times after trimming of the form tile tip.

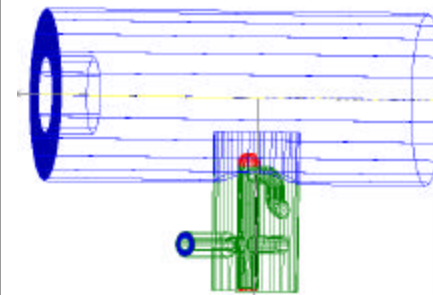
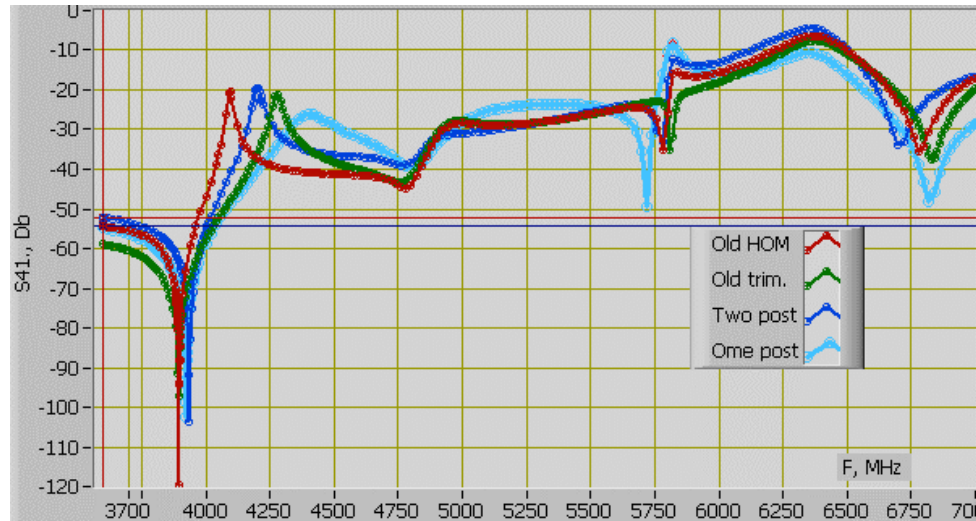
HOM Damping for old HOM design and design with trimmed antenna

Old HOM design before trimming								
Bour	mode	F, MHz	R/Q	Q	Q main C	Q, HOM1	Q HOM2	R/Q*Q
EE	6/9Pi, D1	4874.00	50.00	1.72E+02	2.75E+02	9.32E+02	1.04E+03	8.60E+03
EE	7/9Pi, D1	4937.50	101.00	1.60E+02	2.50E+02	8.67E+02	8.67E+02	1.62E+04
EE	8/9Pi, D1	5013.80	60.00	3.60E+02	6.86E+02	1.95E+03	1.65E+03	2.16E+04
Ohms/sm^2								
EE	6/8Pi, D2	5451.24	42.00	2.54E+04	4.71E+04	2.47E+05	1.16E+05	1.07E+06
EE	5/8Pi, D2	5480.12	32.00	2.54E+04	4.71E+04	1.26E+05	1.16E+05	8.13E+05
Ohms/sm^2								
Old HOM design after trimming								
Bour	mode	F, MHz	R/Q	Q	Q main C	Q, HOM1	Q HOM2	
EE	6/9Pi, D1	4878.00	50.00	1.60E+02	2.84E+02	8.67E+02	7.31E+02	8.00E+03
EE	7/9Pi, D1	4937.50	101.00	1.80E+02	3.06E+02	8.23E+02	8.23E+02	1.82E+04
EE	8/9Pi, D1	5013.80	60.00	3.00E+02	5.18E+02	1.37E+03	1.63E+03	1.80E+04
Ohms/sm^2								
EE	6/8Pi, D2	5451.24	42.00	4.30E+04	7.42E+04	1.97E+05	1.55E+05	1.81E+06
EE	5/8Pi, D2	5480.22	32.00	2.90E+04	5.01E+04	1.24E+05	1.33E+05	9.28E+05



HOM damping for the 1st Dipole band remains same and slightly worth for a 2nd dipole band.

Copper mockups of the HOM.



HFSS model of the HOM installed in the beam pipe



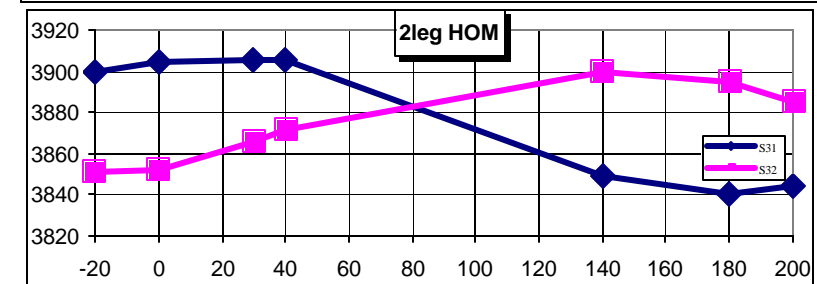
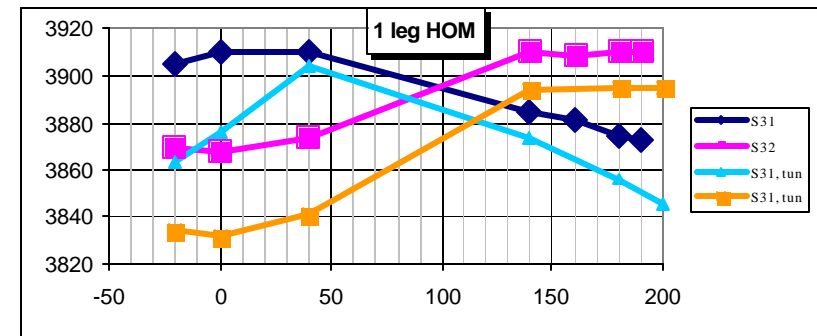
Trimmed tip of the HOM for a 4th cavity.

Calculated transient coefficients from beam pipe to HOM.

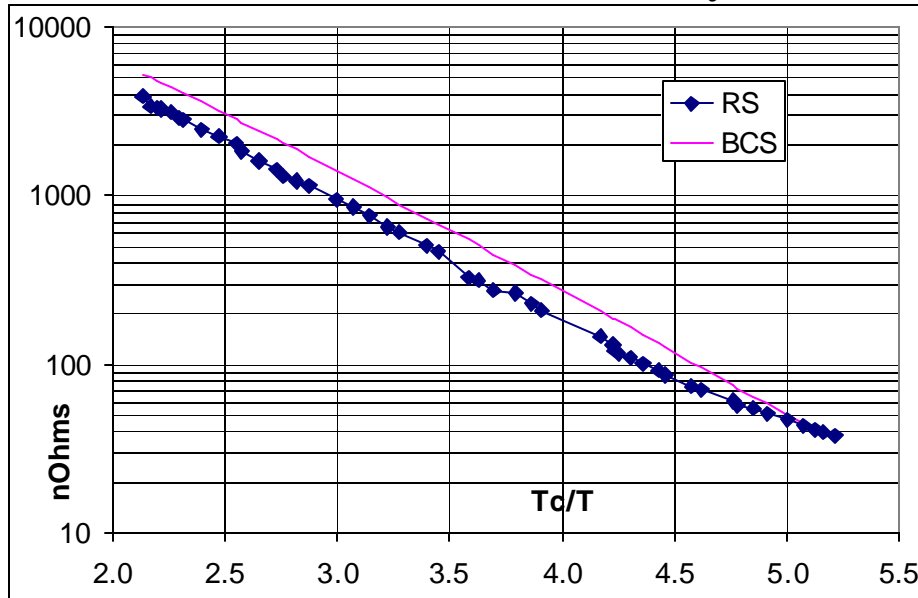


3 versions of the copper mockups of the HOM.
Old, 2 4mm post. Two 6mm post. One 6mm post.

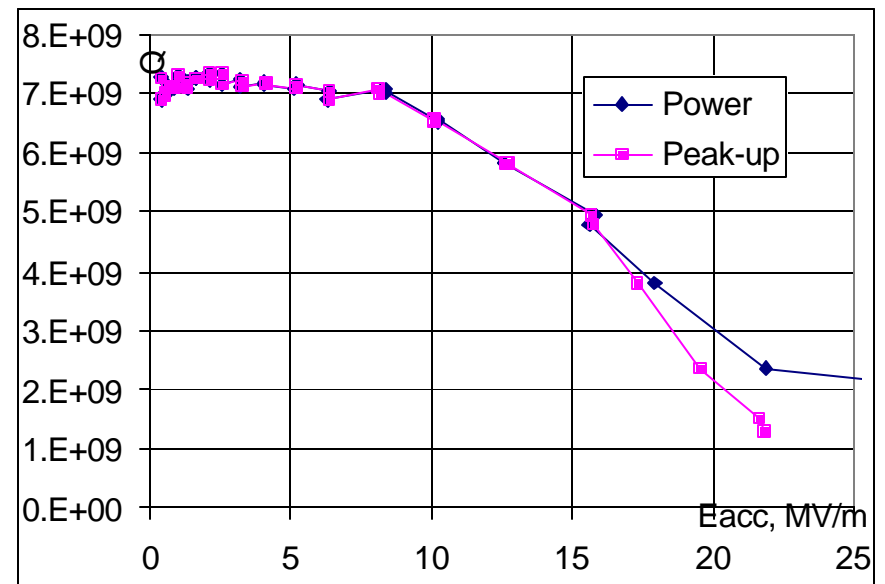
Notch frequency measurements of the 2 copper mockups installed in the cavity.



Nb 9 cell cavity N4. 1st cold test. 2007.04.13.



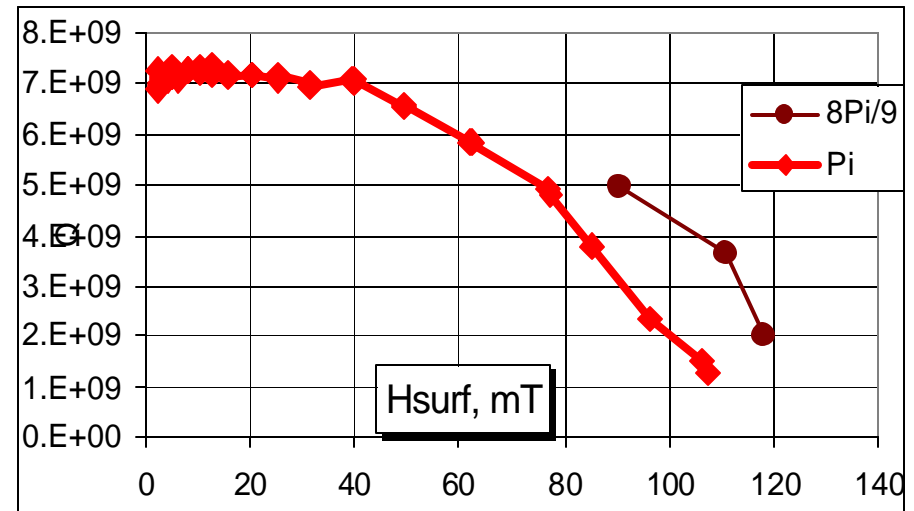
QvsT. Surface resistance R_s 40 nOhms and R_{res} 6 nOhms.



QvsE. $E_{acc}=22$ MV/m with very high x-rays. X-rays starts from 12 mV/m. Limitation X-rays.

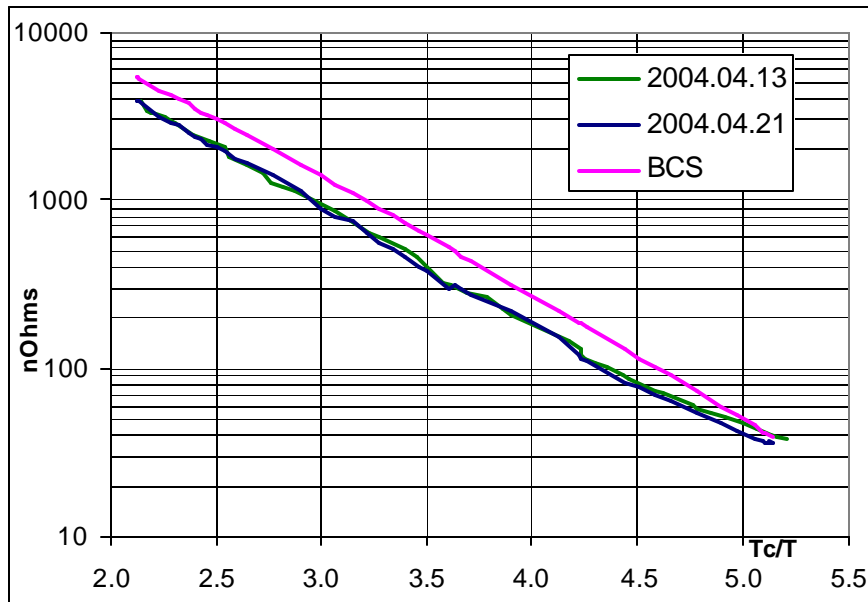


Signals from t-sensors installed in the HOMs. No activity observed during quench (8/9Pi mode).

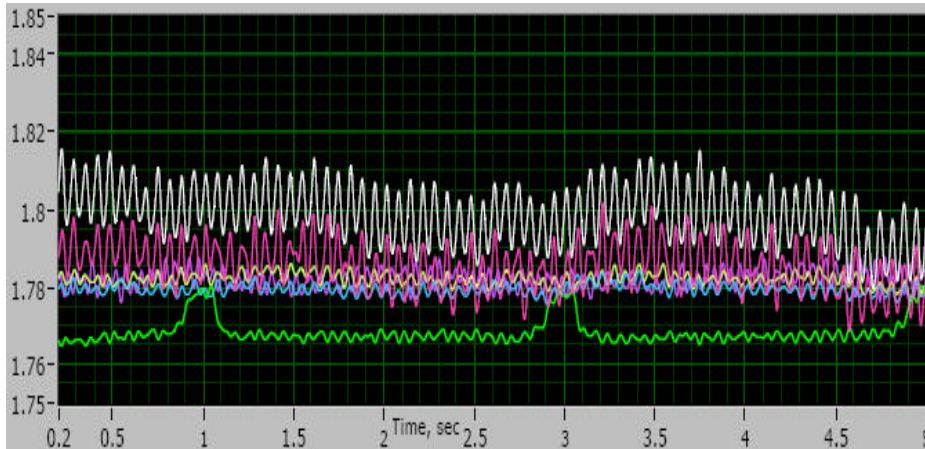


Q vs. max. surface H-field for Pi (limitation x-rays) and $8/9Pi$ (limitation quench) modes.

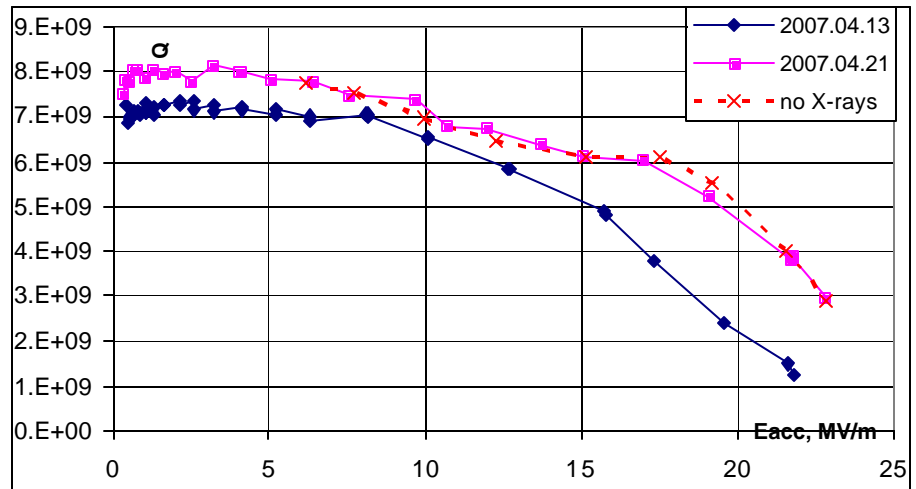
Nb 9 cell cavity N4. 2nd cold test after HPR. 2007.04.21.



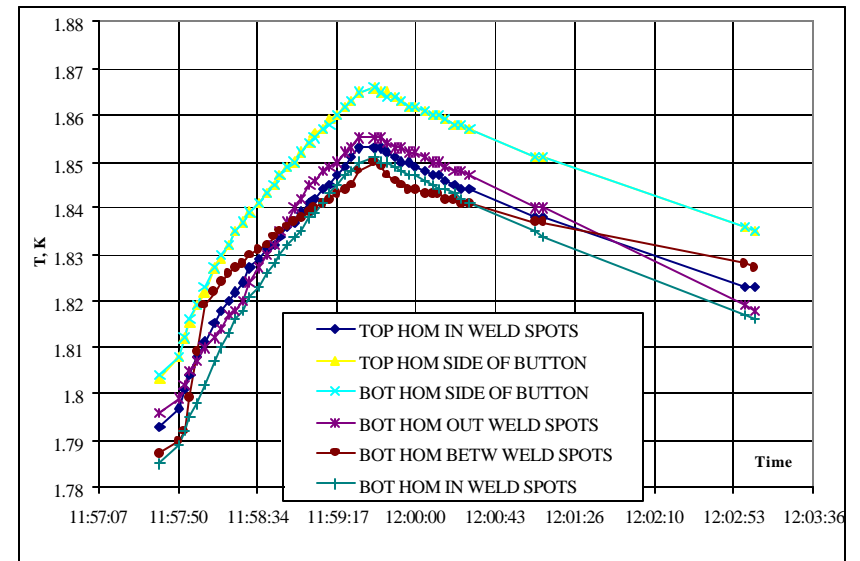
QvsT. Surface resistance R_s 36 nOhms.



Temperature sensor installed in the bottom end cell shows some heating during RF pulse.



QvsE. $E_{acc}=23$ MV/m. Limitation quench in the cavity. It was high x-rays at 15 MV/m. Then something happened and x-ray dropped ~1000 times.



~ 20 MV/m CW. T-sensor installed in the HOMs.

Conclusions:

- The source of the heating of the HOM found.**
- Multipactor calculations and measurement results are in a good agreement.**
- Several new designs of the HOM developed for dumping of the multipactoring.**
- Modified (trimmed) old design HOM coupler allows reduce fields in coupler by factor of ~ 2.5 . It shifts MP threshold to ~ 27 MV/m. Test results (~ 23 MV/m, no MP) are in a good agreement with expectations. Cavities #3-6 will have trimmed design.**
- Prototype of a new one leg design is tested and approved for next Nb cavities. End groups with this design under production.**