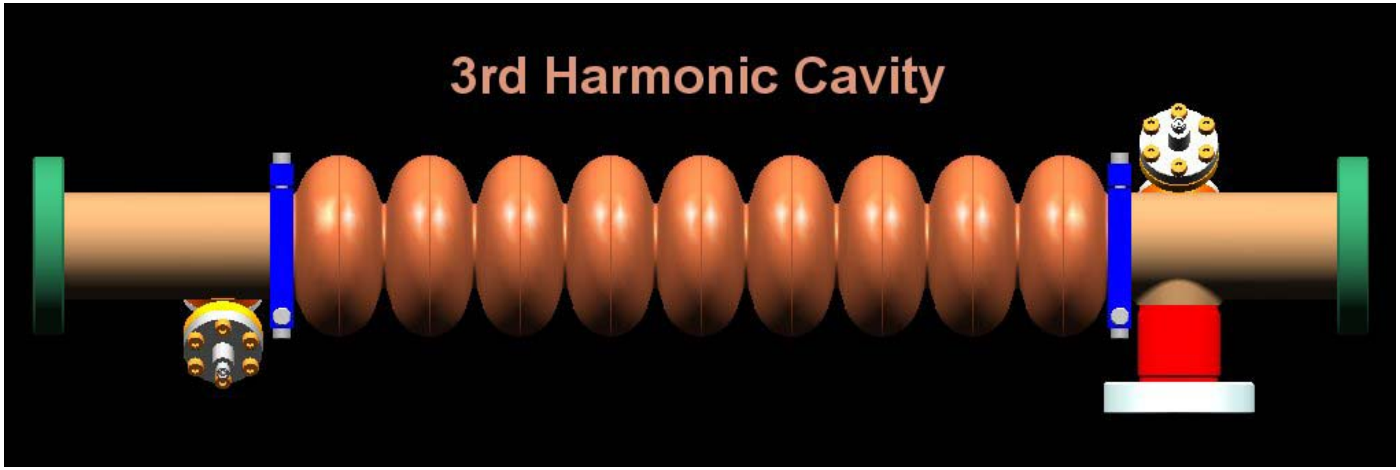
Third Harmonic Cavity Status



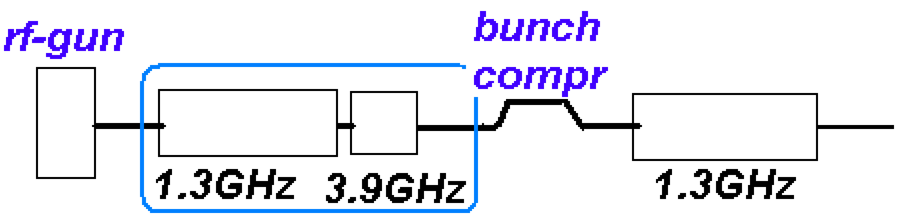
- General parameters
- Cavity design
- Main coupler calculation
- HOM analysis and HOM coupler design
- Lorentz Forces and Stress analysis
- Summary

General parameters

Third harmonic cavity (3.9GHz) was proposed to compensate nonlinear distortion of the longitudinal phase space due to cosin-like voltage curvature of 1.3 GHz cavities.

Parameter List for 3.9 GHz 9-cell cavity:

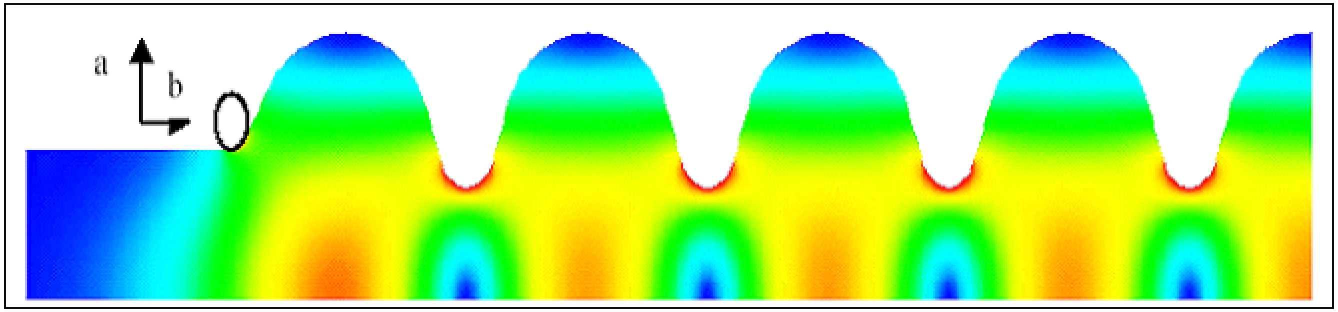
Number of cavities	4
Active Length	0.346 m
Gradient	14 MV/m
Phase	-179 deg
R/Q	778(750) Ω
E_{peak}/E_{acc}	2.26
B_{peak} (E_{acc}=15 MV/m)	0.0727 T
Qext	9.5e+5
BBU limit for HOM, Q	<1.e+5
Total energy	20 MeV
Beam current	9 (12) mA

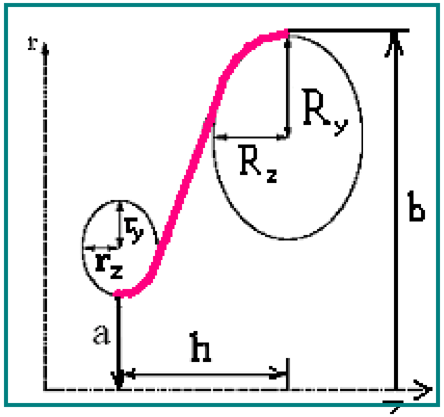


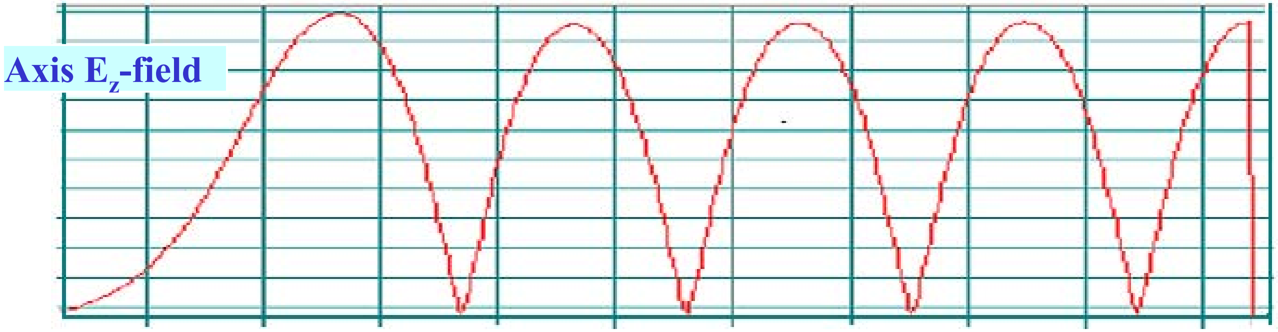
Steps to build 3rd harmonic cavity:

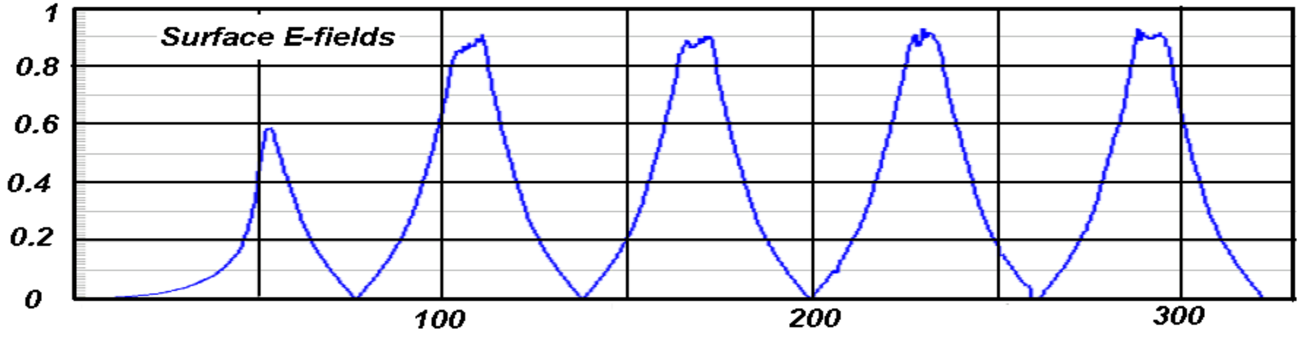
- Cu model
- Main Coupler
- HOM coupler
- Nb model
- He vessel with tuner
- Cryostat

Cavity with increased end-cell iris (30→40mm)



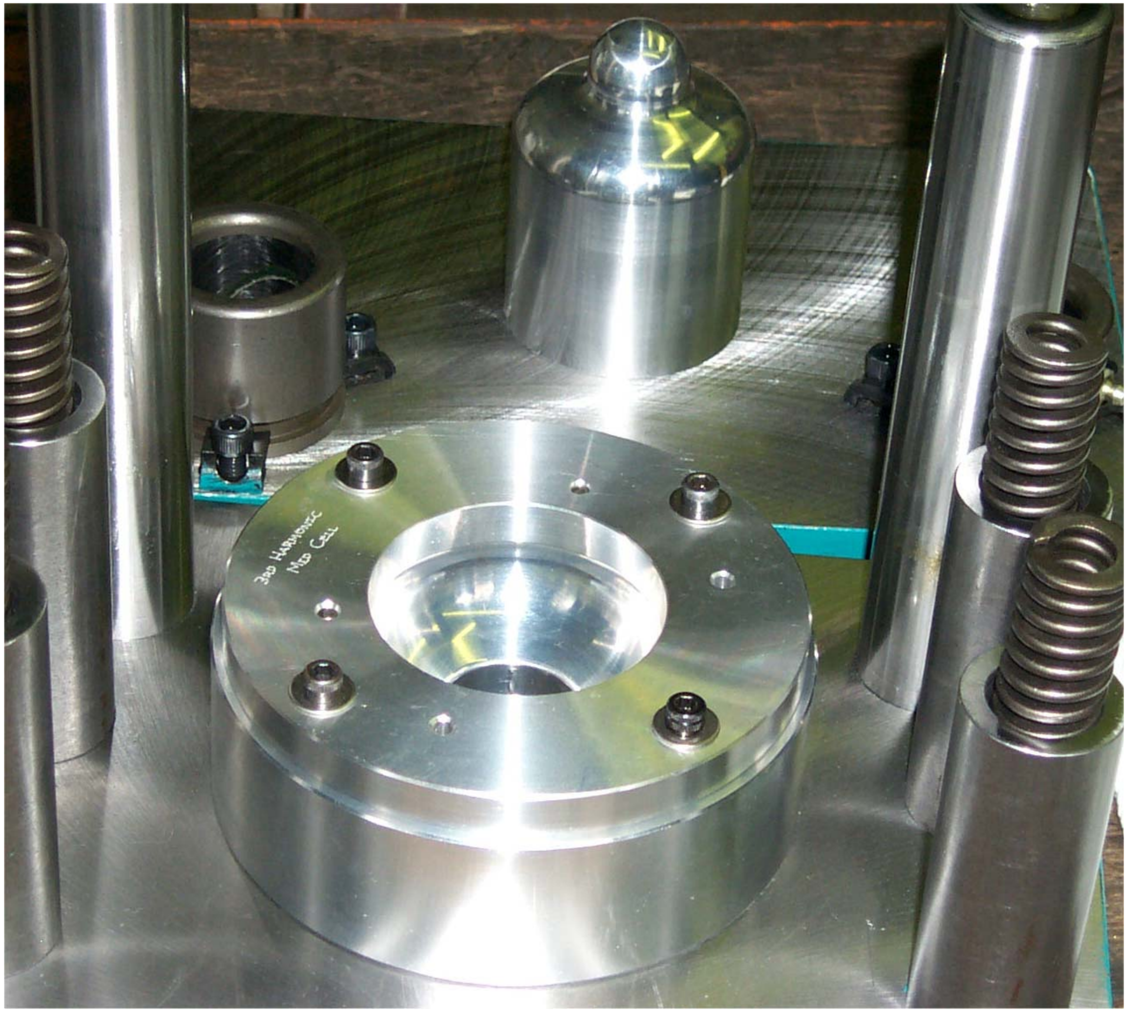






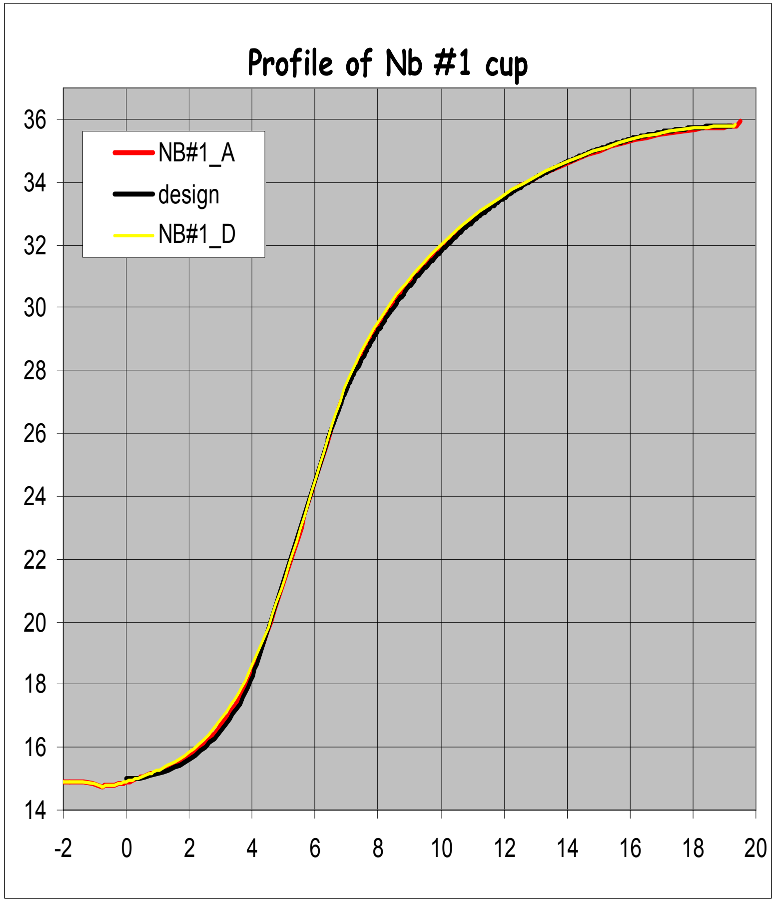
	mid	end	end1
h	**19.217**	**same**	**same**
a	**15**	**15**	**20**
b	**35.787**	**same**	**same**
ry	**6**	**same**	**same**
rz	**4.5**	**same**	**same**
Ry	**15**	**same**	**same**
Rz	**13.6**	**12.08**	**14.4**

Cups production and QC measurements



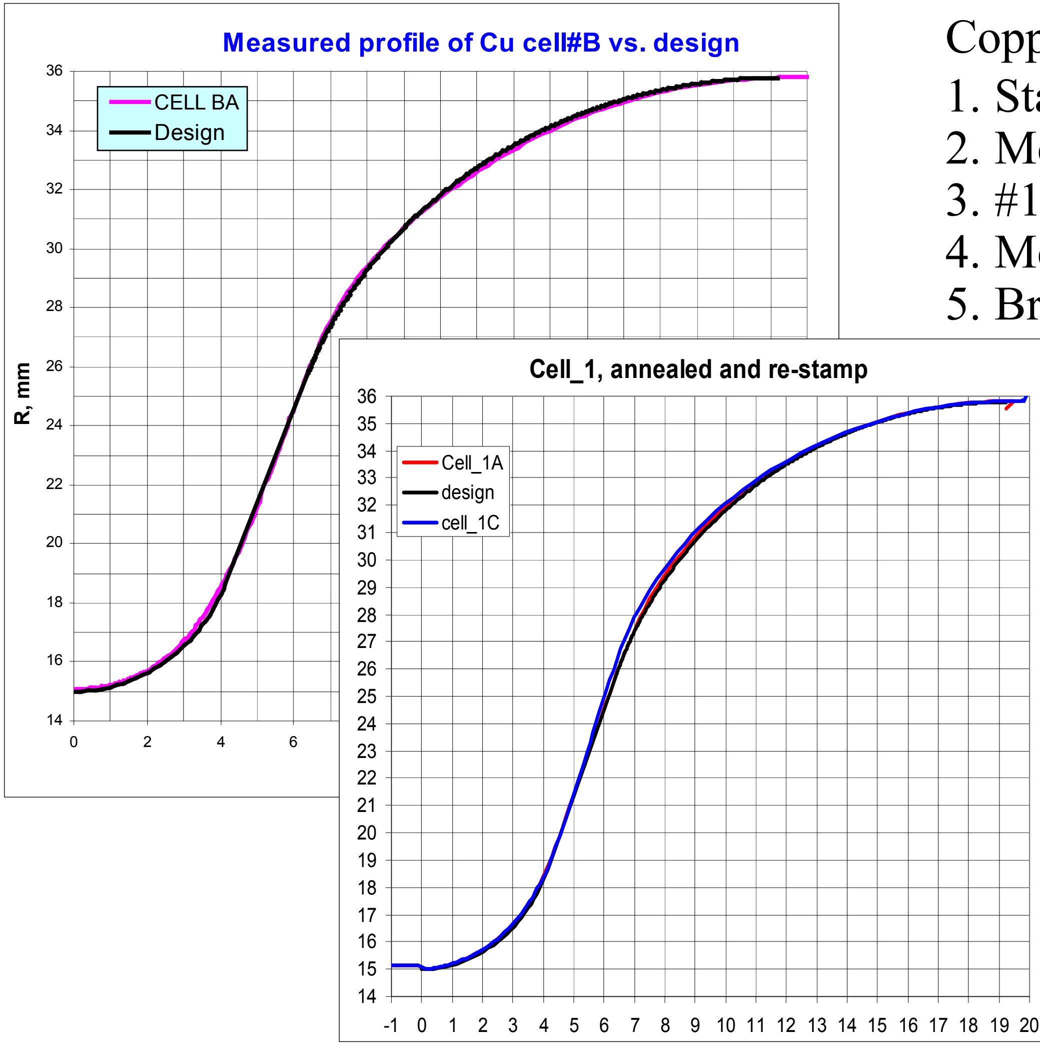
- Dies for mid-cell (Rutgers Univ)
- Coin for iris shaping
- Dies for end-cell (delayed)
- 2+6 (+24) Cu cups
- 4 (+2) Nb cups
- Mechanical and RF QC done on each step

Nb cups production



- Produced 4 Nb cups 2.8mm thickness for welding test (Oct,2002)
- Blanks for 2 more cups to check profile and RF QC, then anneal and re-stamp.

Mechanical and RF quality control



Copper Cups #A,#B, #1-6

1. Stamped and coined
2. Mechanical and RF QC
3. #1-6 Annealed, re-stamped, re-coined
4. Mech and RF QC, facing
5. Brazed 2 dumbells: (1-2) and (4-5)

Results of RF measurements

Design	**F0=3742.4**	**F_π =3900**
#B Stamped, Coined	**F0=3749.3**	**F_π=3916.1**
HFSS calculation	**F0=3749.5**	**F_π=3914.1**
#1 Annealed St&Co	**F0=3726.4**	**F_π=3887.8**
HFSS calculation	**F0=3724.9**	**F_π=3885.8**
Brazed dumbbells:		
(#1-#2)	**F0=3724.9**	**F_π=3885.8**
(#4-#5)	**F0=3721.0**	**F_π=3880.4**
(1-2)+(4-5)	**F0=3723.1**	F_π=3883.2

Repeatability ±(2-2.5) MHz (6 pcs)

Dumbells

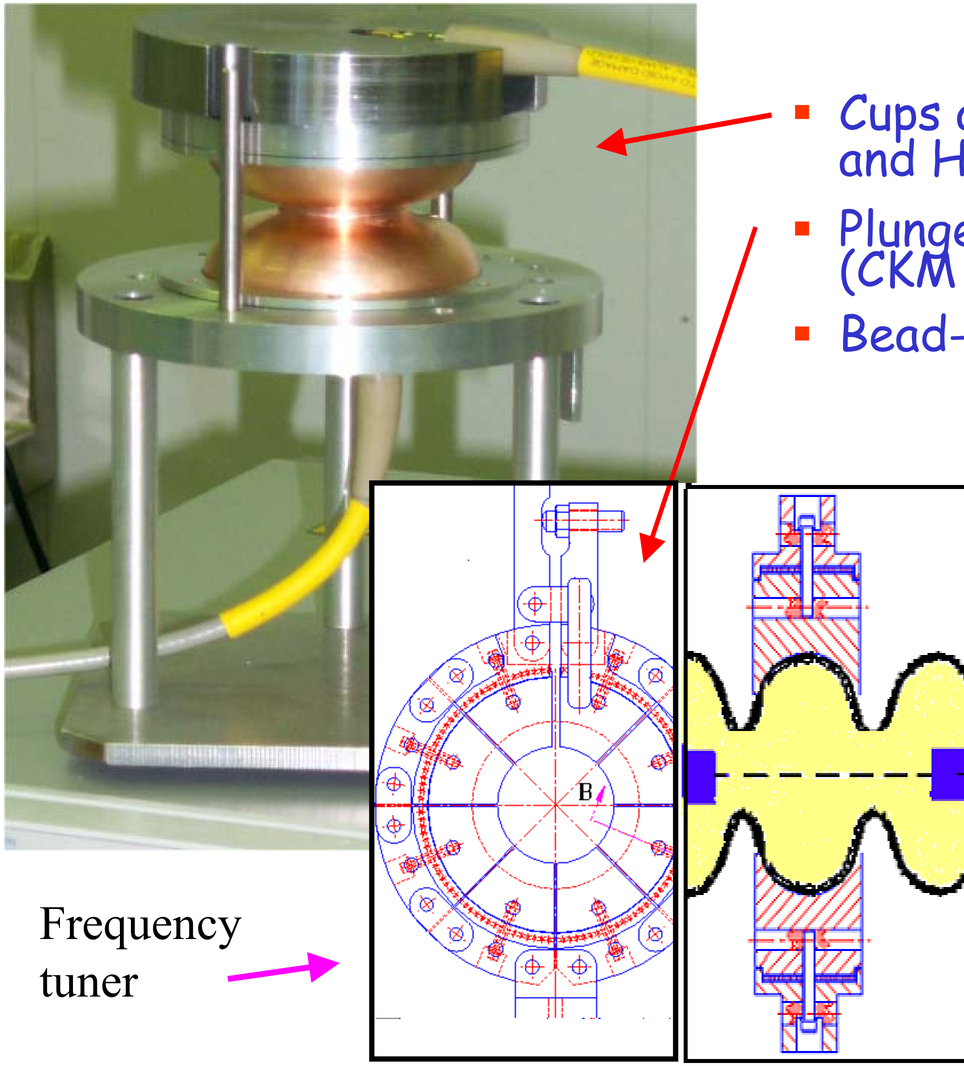
Carbon support is used for aligning and brazing of cups

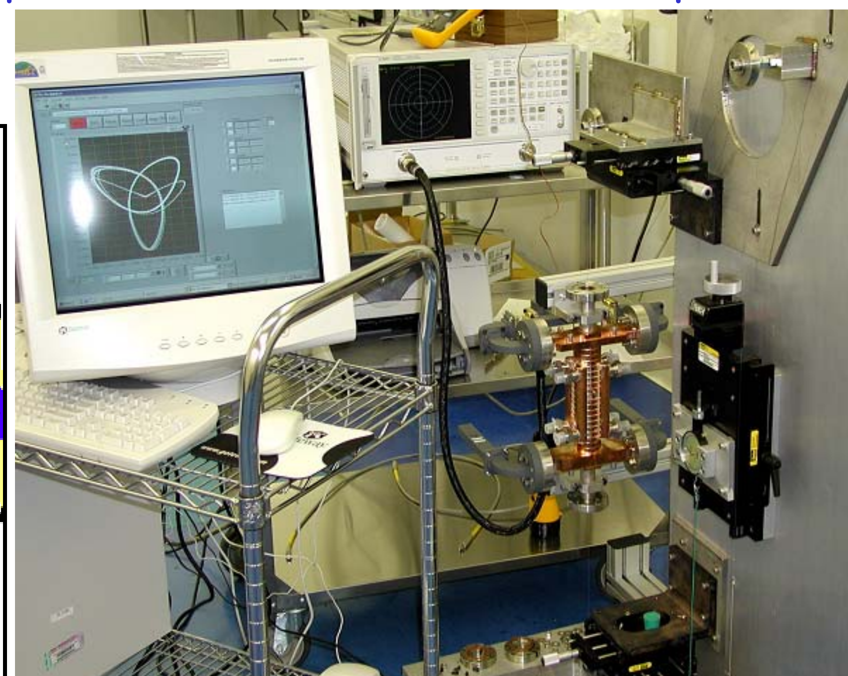
Two dumbells brazed in vacuum furnace (65Cu/35Au)

RF and mechanical QC

RF set-ups

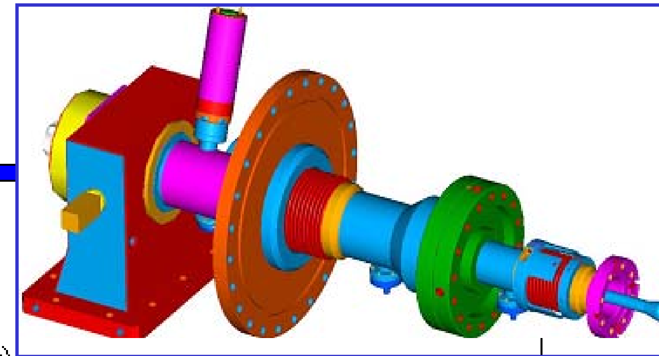
- Cups and dumbell RF QC, (fundamental and HOM modes)
- Plunger measurement and cavity tuning (CKM set-up upgrading)
- Bead-pull measurements (NLC set-up)

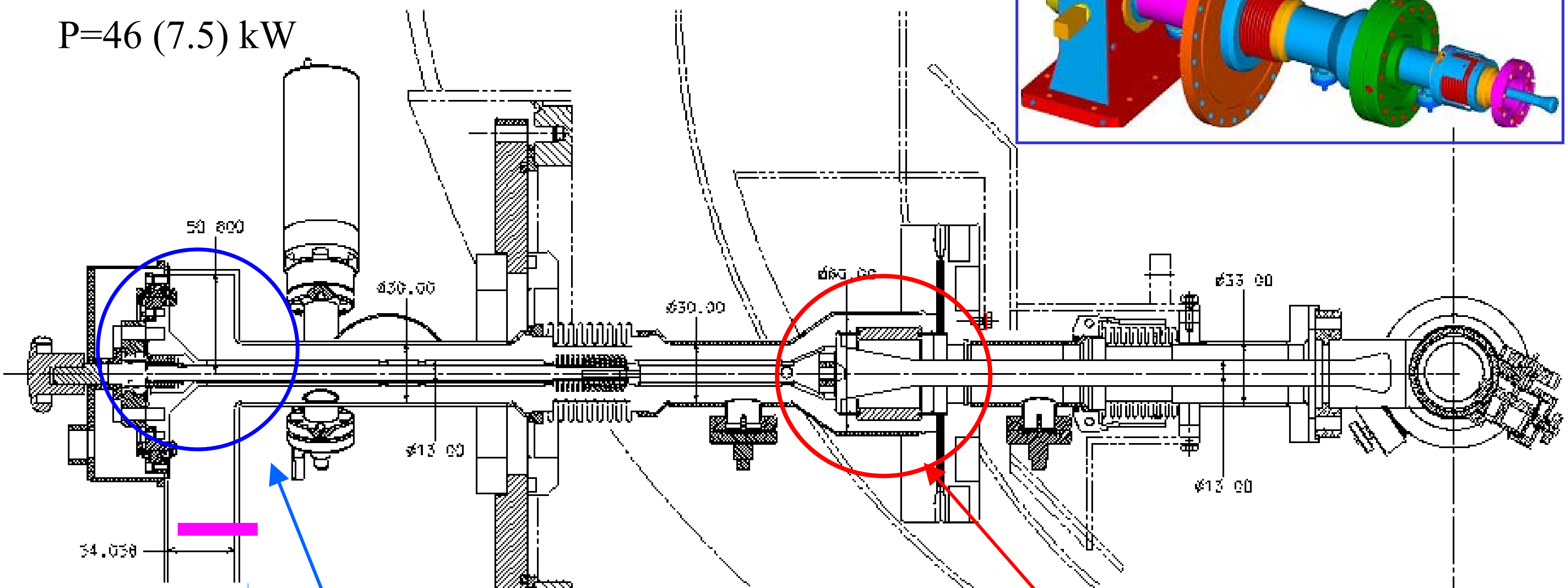


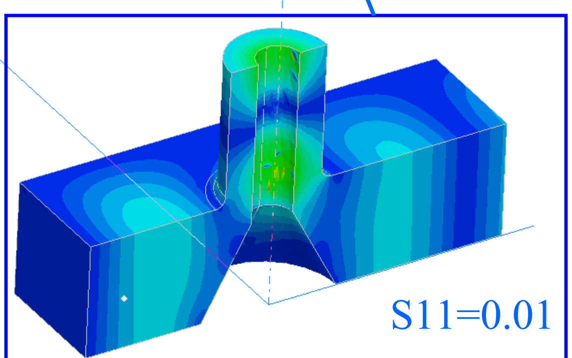


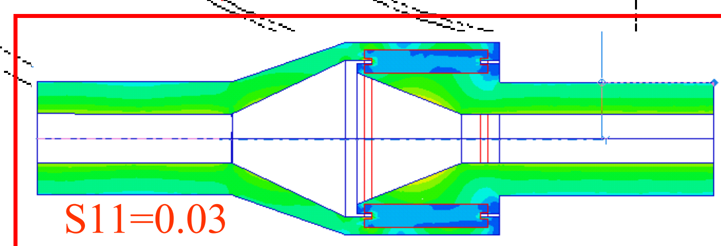
Main Coupler Design

P=46 (7.5) kW

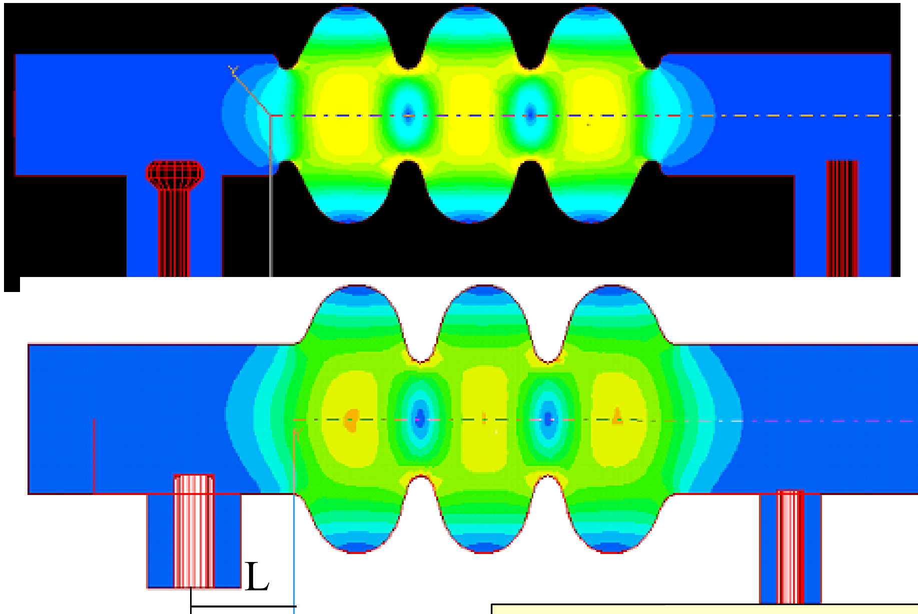






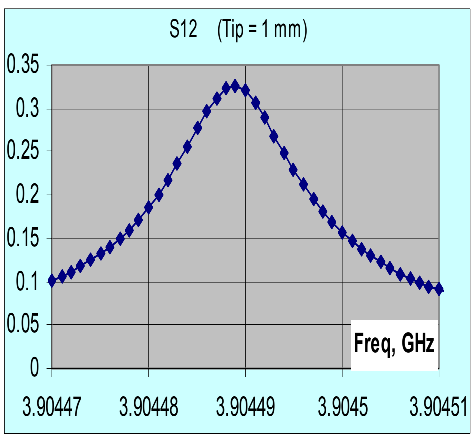


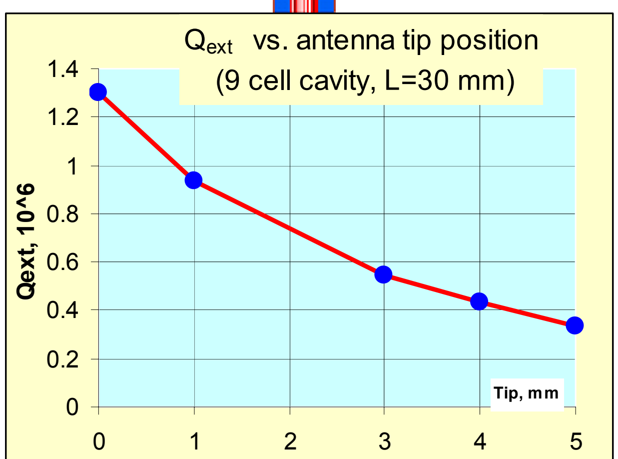
Coaxial coupler (HFSS simulation)

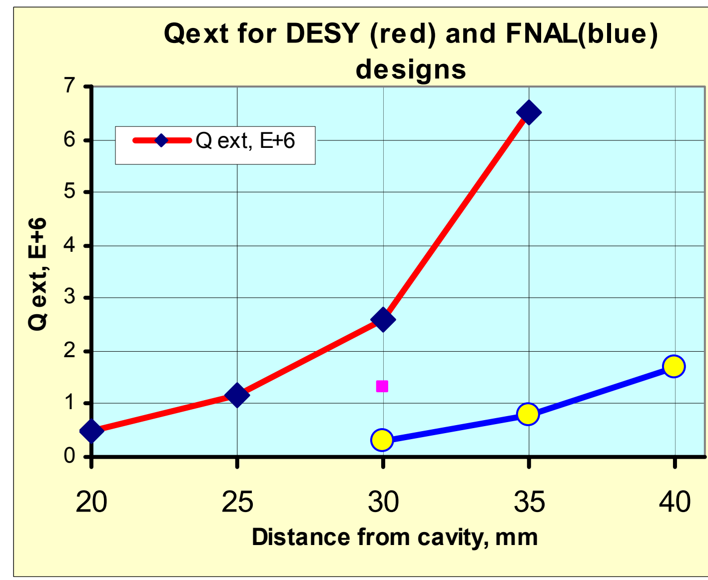


Designed Q_ext = 9.5 e+5

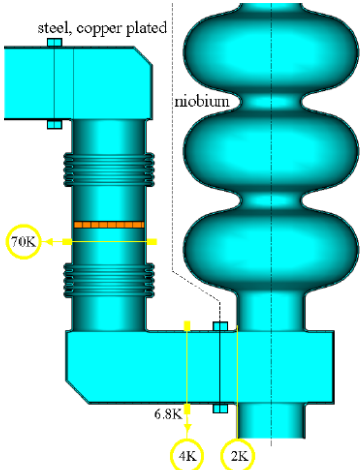
- Coax geometry: ∅=30mm, Z=50 Ω, antenna -5mm inside tube. Second antenna (from right) is used as pick-up.
- Most calculations have done for 3cell geometry. After optimization was checked for 9-cell. ($Q_{9cell} = 3*Q_{3cell}$).
- To provide needed Qext, coupler should be placed very close to cavity (25mm) for geometry on the top picture. Increasing end-cell iris from 15mm to 20mm (bottom geometry) allow move coupler away from the cavity (35mm).



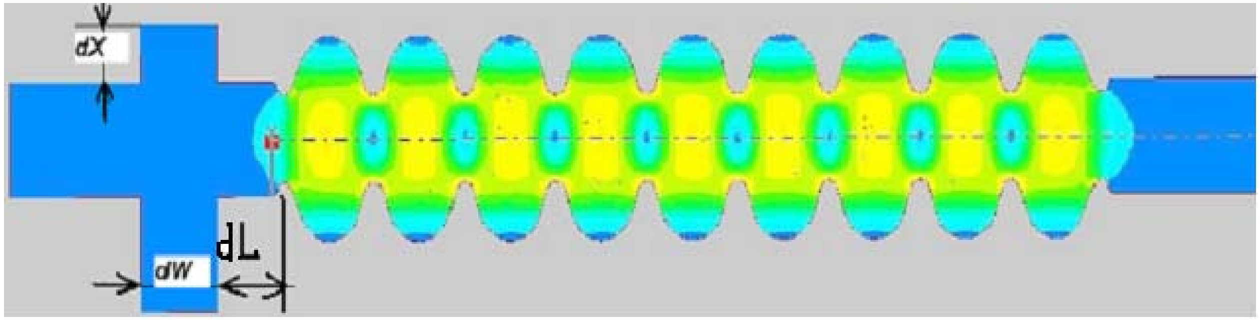


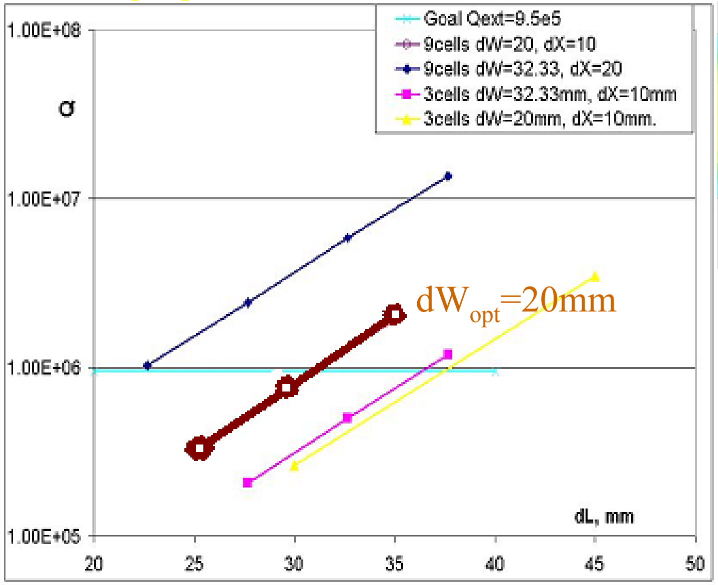


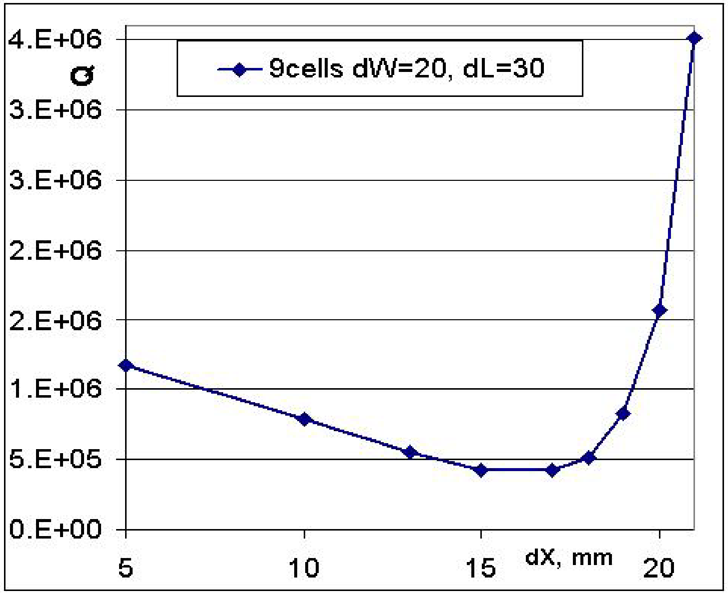
Waveguide type coupler

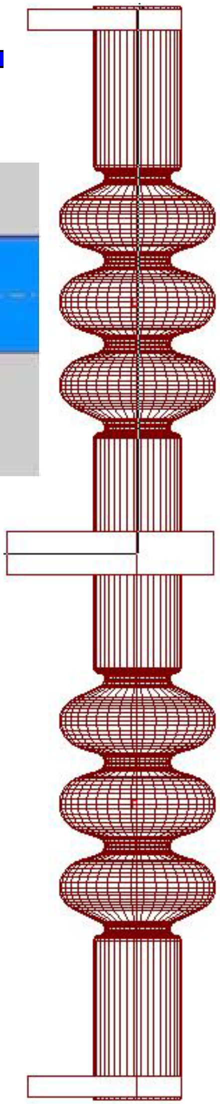


HFSS model

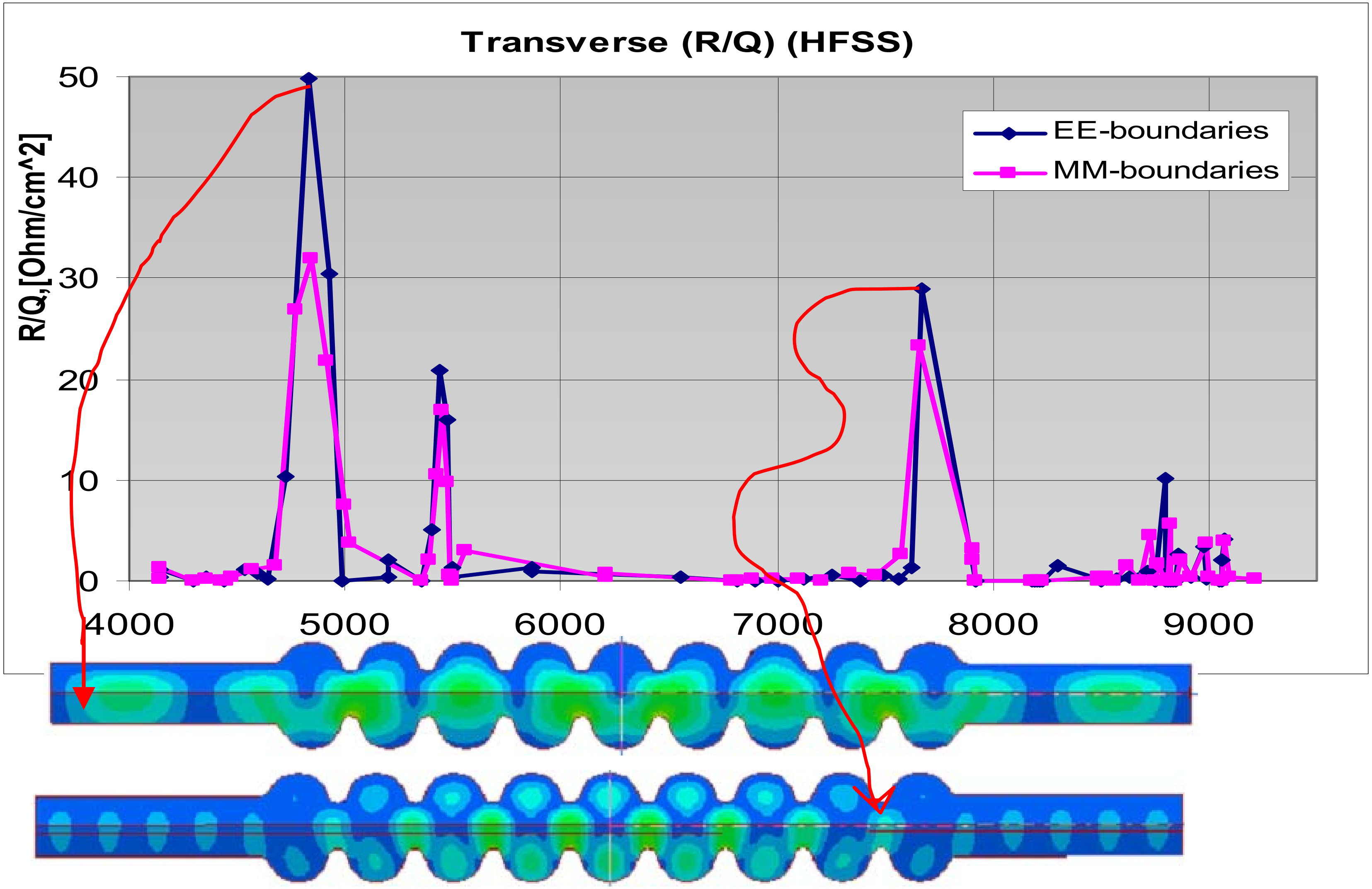




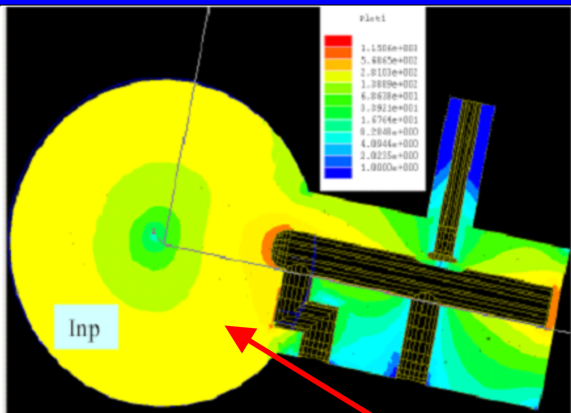




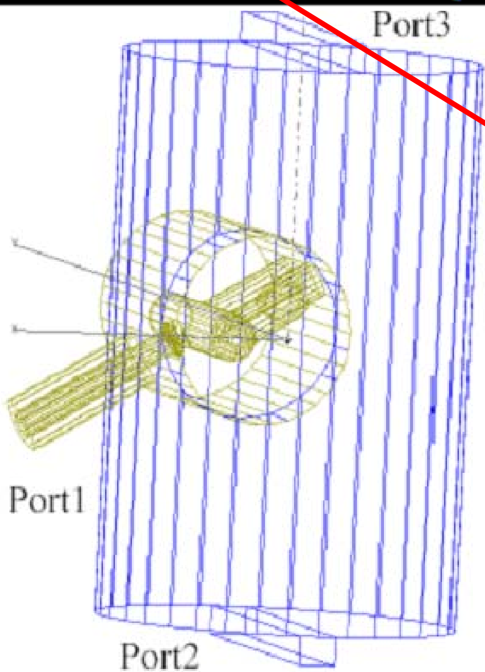
High Order Modes (HFSS simulation)



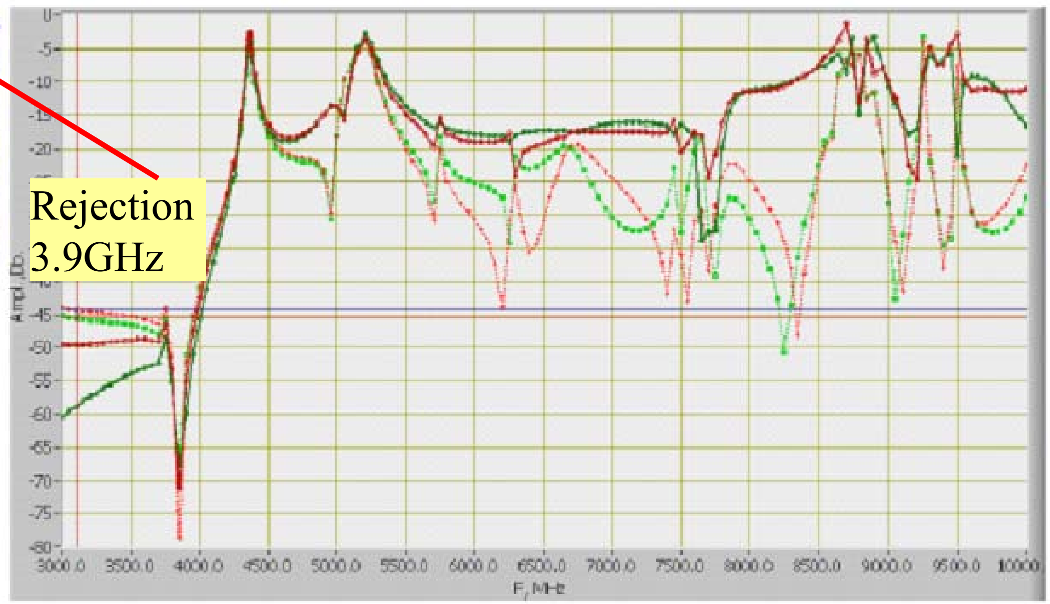
HOM coupler design



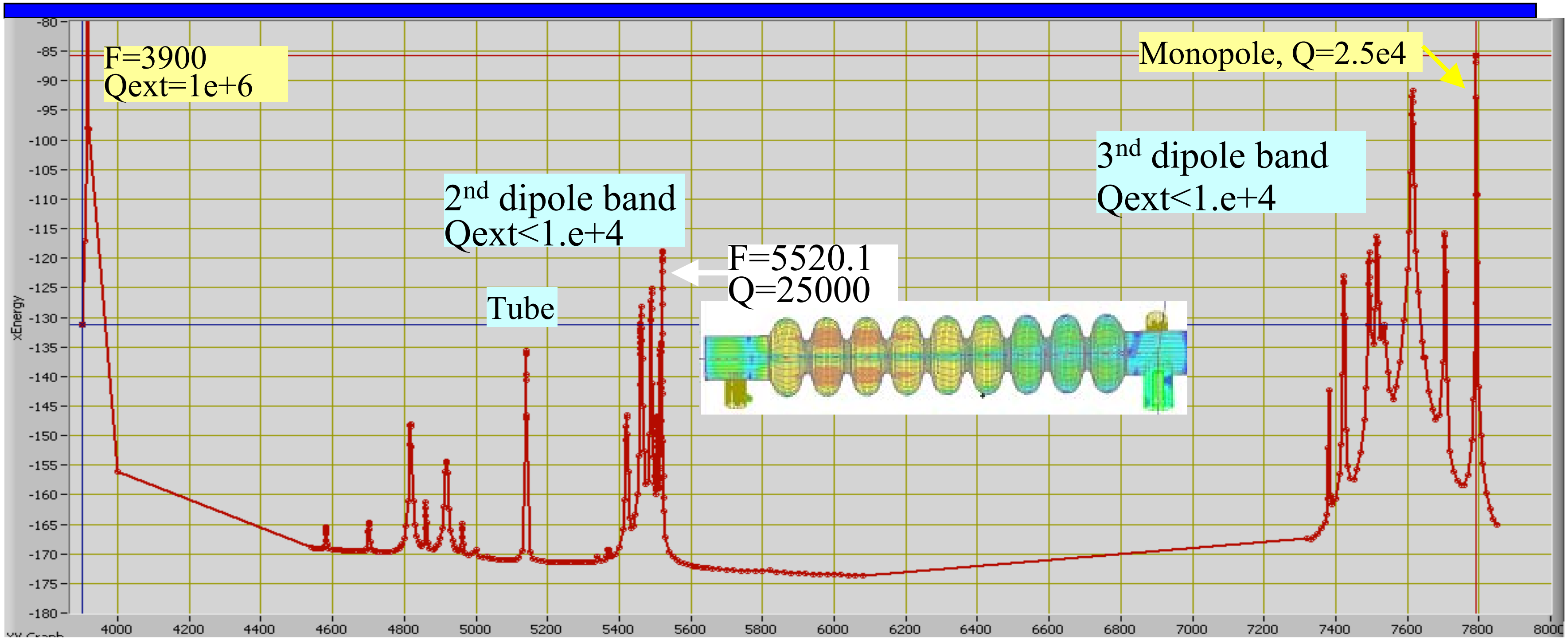
HOM coupler design proposed by J.Sekutowich (scaling of TTF design). We re-calculated and optimized this design (Initial design had 3.32 rejection frequency)

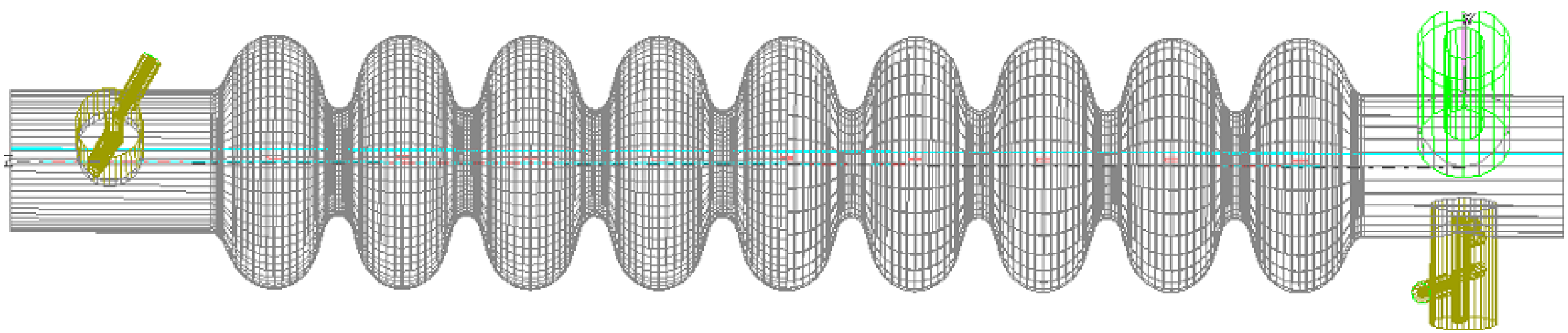


S21 and S31 when waveguides in xz plane – solid lines
S21 and S31 when waveguides in yz plane – dotted lines

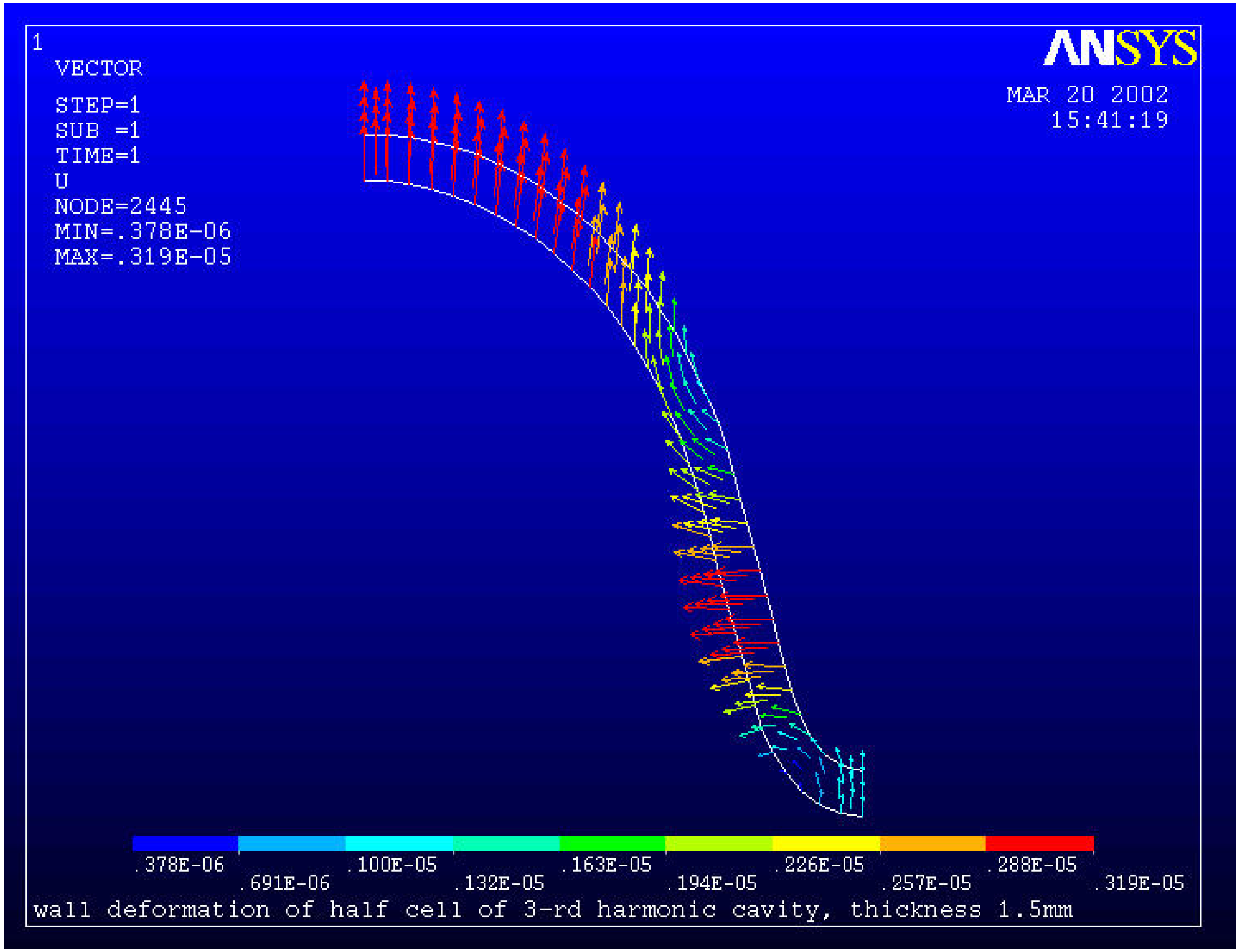


Cavity excited by the beam (2mm off-set)





Frequency shift due to Lorentz forces



- **HFSS simulation of half cell**
  - $P = (\mu_0 H^2 - \varepsilon_0 E^2)/4$
  - data exchange (HFSS-ANSYS)

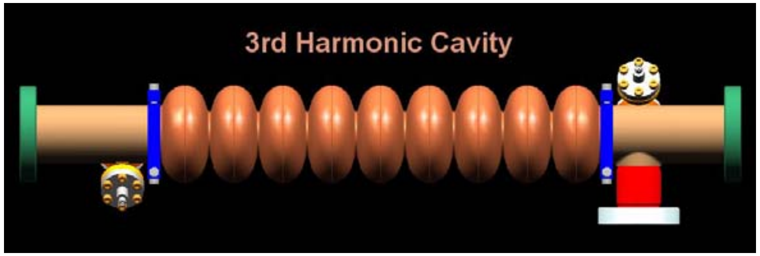
ANSYS simulation of stresses in half cell
  - different wall thickness
  - Yung modulus, Poisson's ratio
- **Frequency shift due to Lorentz force (Slater's Theorem)**
- $\Delta F = 1/(4W)\, F \int_{\Delta V} (\varepsilon_0 E^2 - \mu_0 H^2)\, dV$

Thickness (mm)	ΔF (Hz)
1.5	200
2.8	90

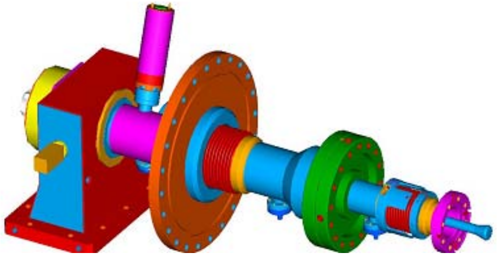
Displacement of the cell wall due to Lorentz force. Wall thickness T=1.5 mm.

Summary

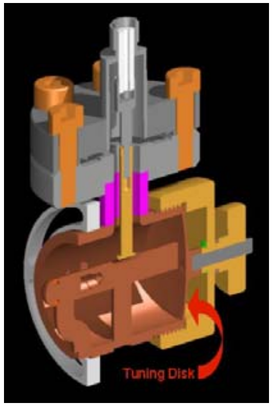
- Cavity design
  - Start production of cups, dumbells, tubes, couplers
  - Mechanical and RF QC for production feed-back
  - Tooling and RF set-ups in progress



- Main coupler
  - Calculation done
  - Design in progress



- HOM analysis and HOM coupler design
  - HOM analysis in progress
  - HOM coupler design is finished, Cu model is ordered (delivery Nov, 2002)



- Lorentz Forces and Stress analysis done.

team:

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help: V.Yarba, D.Finley, L.Bellantoni, D.Snee, T.Arkan, H.Carter, B.Smith, A.Rowe.