STRUCTURAL ANALYSIS OF SINGLE CELL SUPERCONDUCTING ELLIPTICAL CAVITY WITH STATIC LORENTZ FORCE

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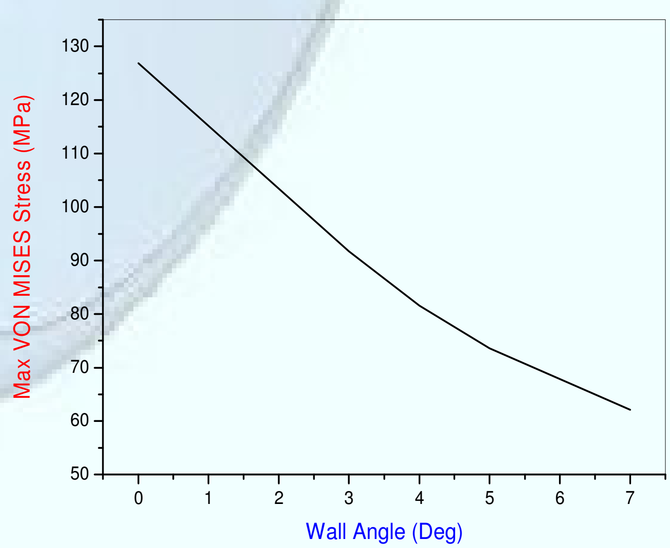
INTRODUCTION

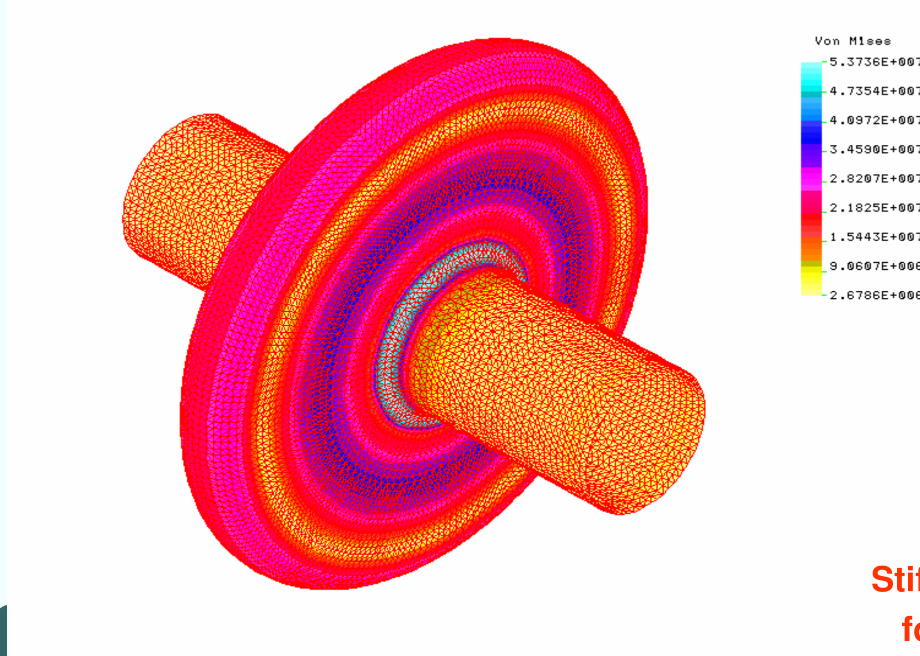
- The structural behavior of the single cell elliptical cavity has been studied by finite element structural analysis using COSMOS/M
- The resonant frequency shift due to vacuum load has been calculated from the frequency sensitivity data of SUPERFISH code.
- The frequency shift due to Static Lorentz Force has been calculated using SUPERFISH code.
- Cavities mechanical resonant frequencies were calculated for two different boundary conditions.

STRUCTURAL ANALYSIS FOR VARIOUS SHAPE PARAMETERS

- The Max. Von MISES Stress is minimum for round shape equator.
- The Max. Von MISES Stress is significantly decreased by increasing wall angle.
- The Max. Von MISES Stress dose not depend so much on iris ellipse.
- The Max. Von MISES Stress decreases significantly with increasing iris radius.

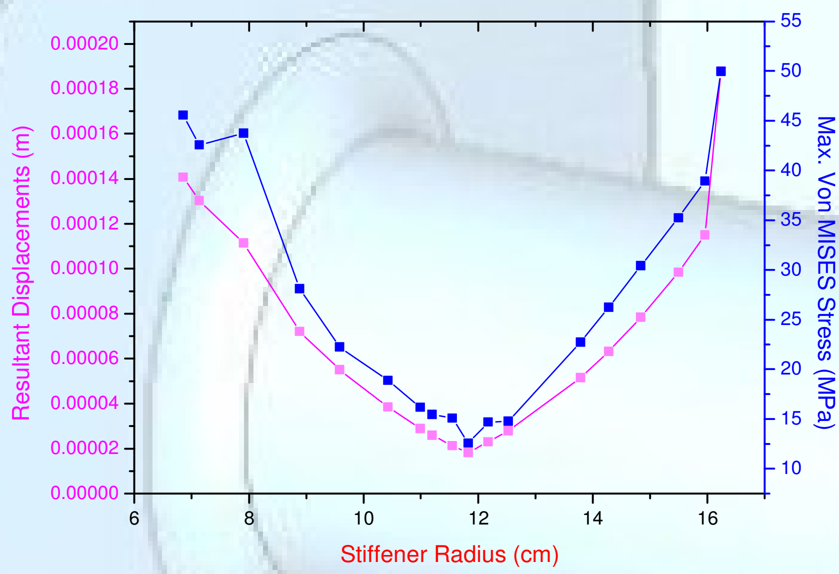
Max. Von MISES Stress for 3 mm Niobium with various wall angle



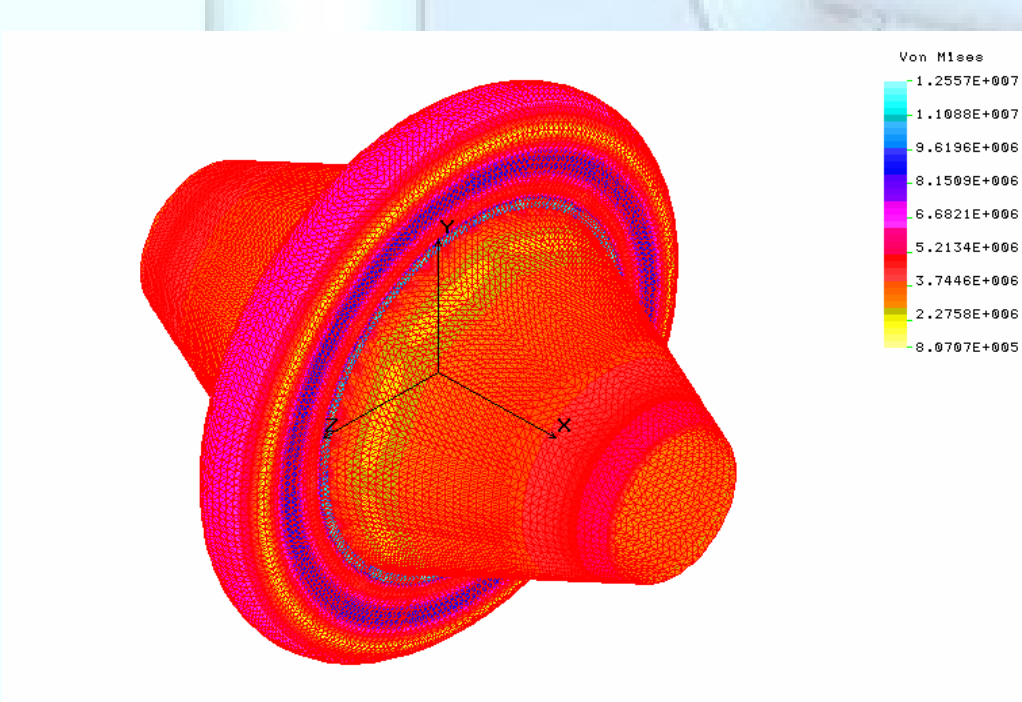


Stress distribution in a 3 mm Niobium cavity without stiffener.

Stiffener radius optimization for 3 mm Niobium Cavity.



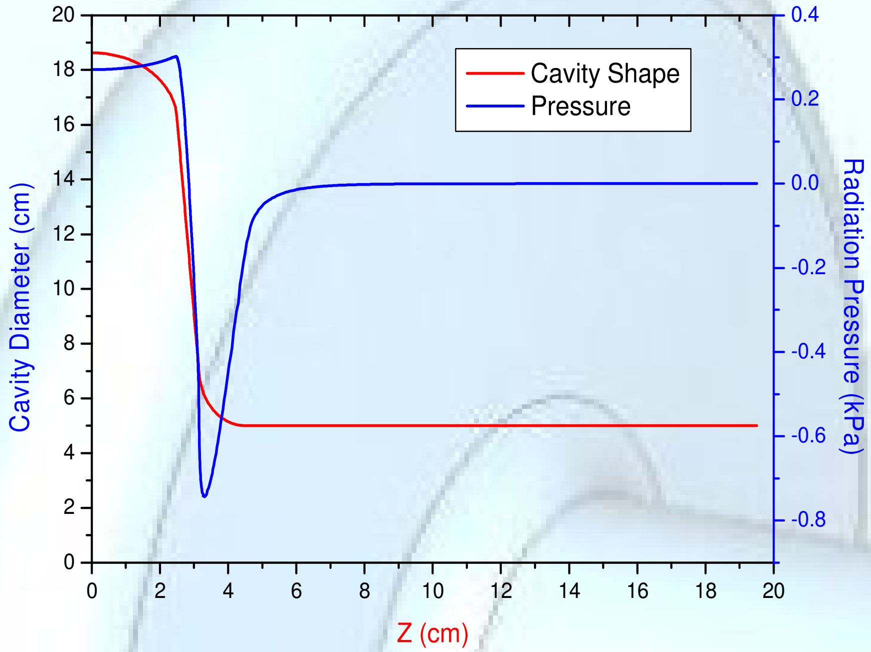
Stress distribution in a 3 mm Niobium cavity with conical stiffener



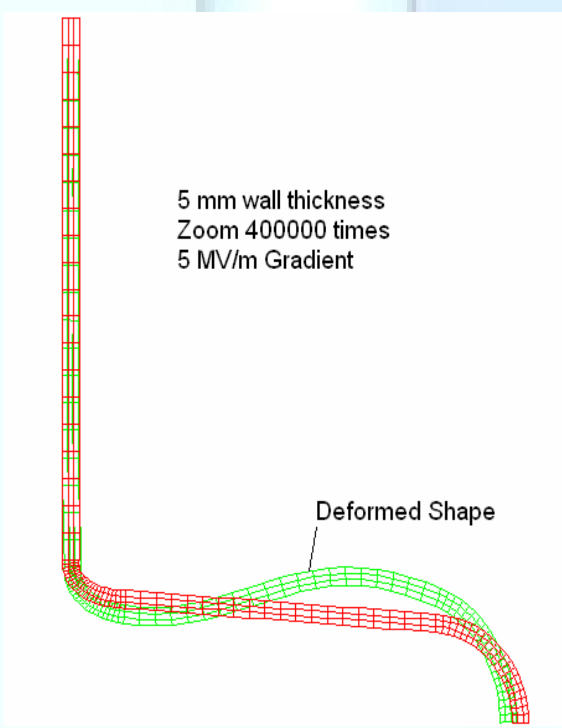
STATIC LORENTZ FORCE DETUNING ANALYSIS

The radiation pressures on the cavity wall is given by the equation

$$P = \frac{1}{4}(\mu_o H^2 - \varepsilon_o E^2)$$



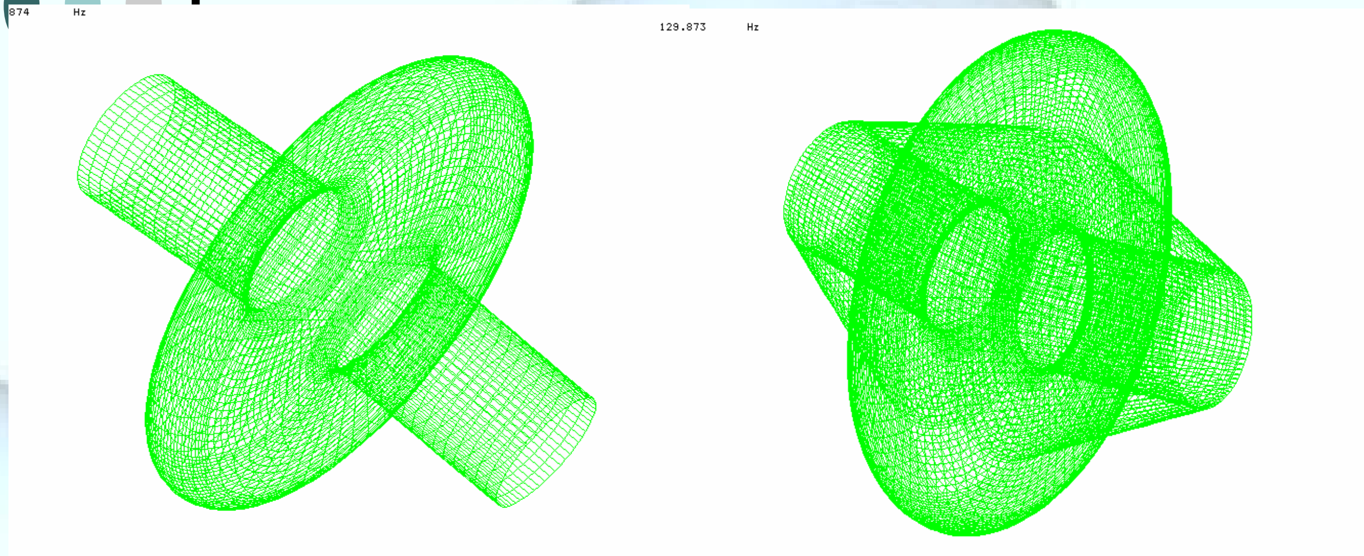
Lorentz Pressure Deformation for 5 mm wall thickness



Materia l	Wall Thic k	Δf (Hz) @ 5 MV/m	Δf (Hz) @ 10 MV/m	K_L Hz/ MV/ m
Copper	3 mm	-243	-1159	-10.7
Niobiu m	3 mm	-212	-1007	-9.3
Copper	4 mm	-135	-625	-5.8
Niobiu m	4 mm	-118	-545	-5.1
Copper	5 mm	-86	-396	-3.7
Niobiu	5	-75	-345	-3.2

DYNAMIC ANALYSIS OF SINGLE CELL CAVITY

Lowest mode of 5 mm Niobium Cavity



Without Stiffener

With Stiffener

Material	Wall Thick	Lowest Frequency		
		Both end Fixed Hz	One end Free Hz	One end Free with Conical stiffener Hz
Copper	3 mm	212	61	130
	4 mm	245	71	153
	5 mm	281	81	172
Niobium	3 mm	231	66	141
	4 mm	267	77	166
	5 mm	305	88	187

CONCLUSIONS

- Structural properties of Niobium is slightly better than Copper.
- For 3 mm Niobium cavity the calculated frequency shift due to vacuum load is 306 Hz/millibar and for 5 mm Niobium it is 74 Hz/millibar.
- Frequency change due to static Lorentz force is quite low for 4 mm and 5 mm wall thickness.
- For 3 mm wall thickness stiffener is essential.
- Also Stiffener will be required if operated more than 5 MV/m accelerating gradient.