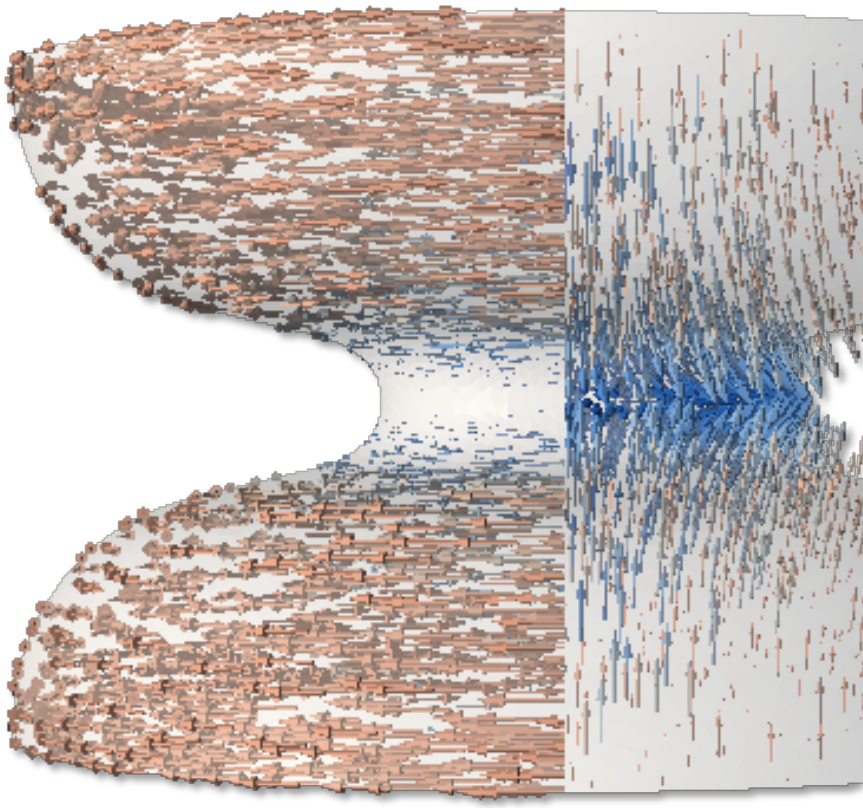
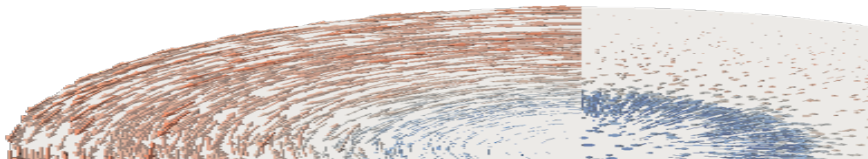
SPL Dumb-Bell Measurements

An Approach



SLHiPP – 09/12/2011

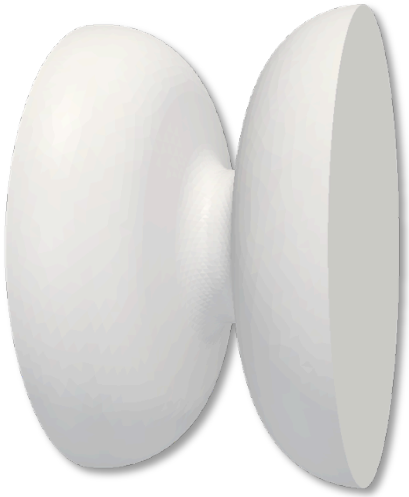
N. Schwerg - BE RF KS



Outline

Half-Cells measurements show frequency variations of more than 1 MHz

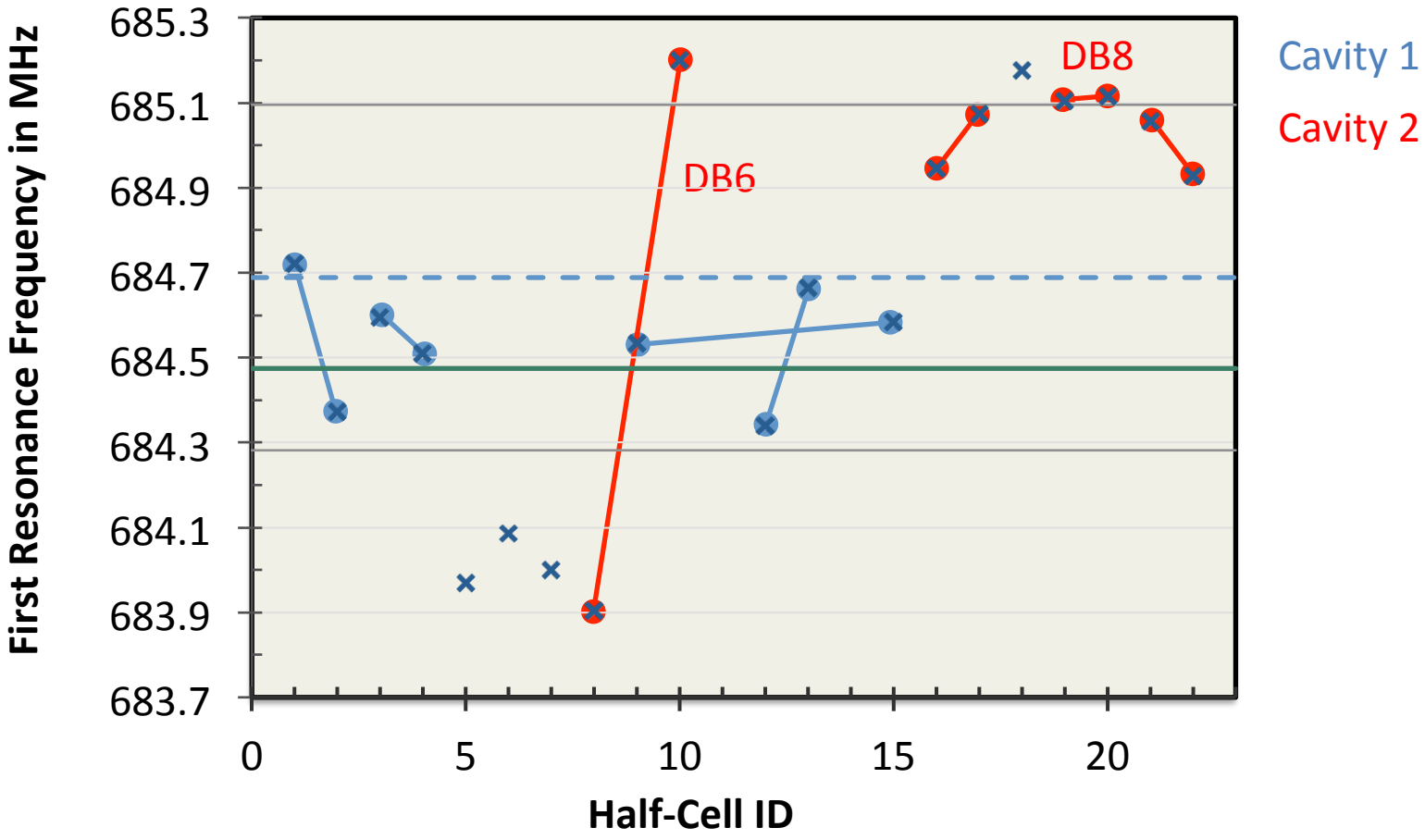
Trimming, **combination** and welding to **Dumb-Bells**



Measurements, trimming and combination

Welding to **5-Cell SPL-Cavity** and field-flatness measurements

Half-Cell Combination



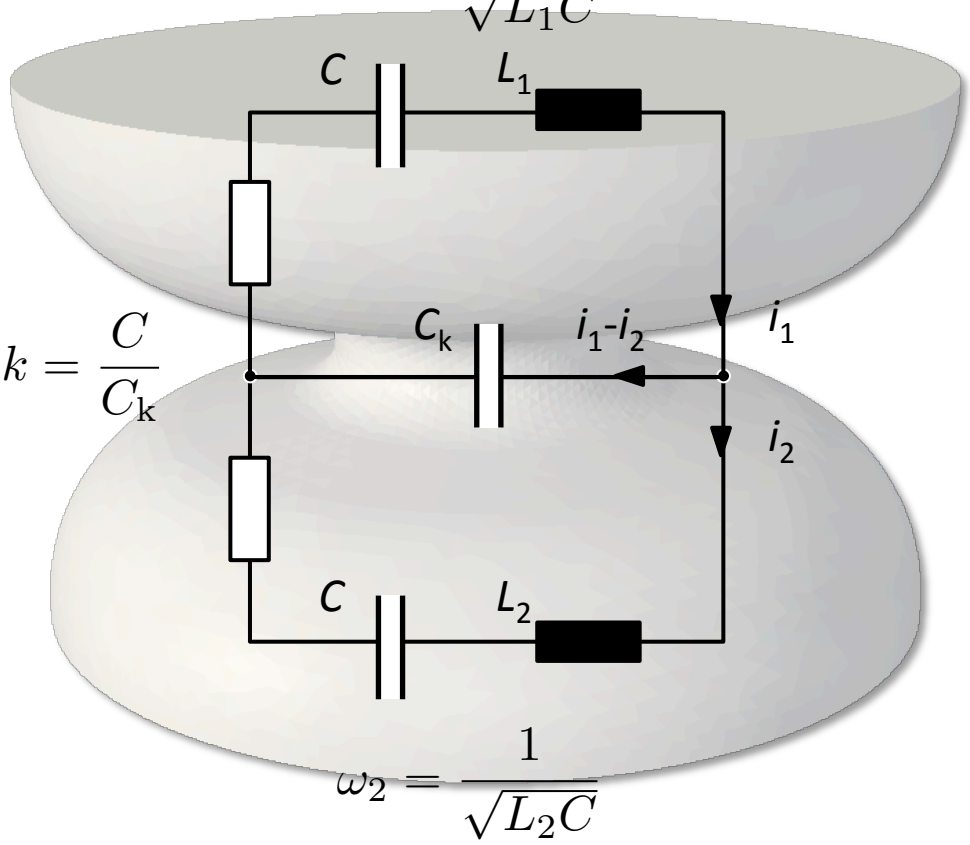
Which influence has the combination scheme on the dumb-bell?

Dumb-Bell Model

Two different Resonance Frequencies

$$\omega_1 = \frac{1}{\sqrt{L_1 C}}$$

Fixed Coupling $k = \frac{C}{C_k}$



$$\omega_2 = \frac{1}{\sqrt{L_2 C}}$$

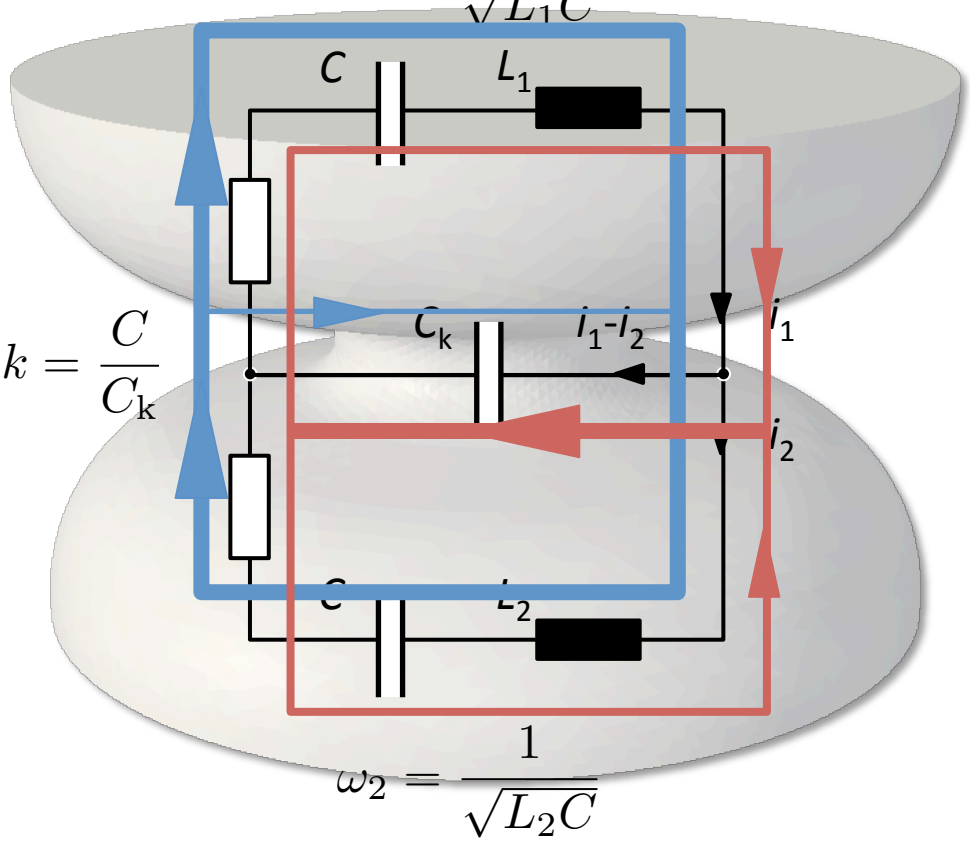
Quadratic **Eigen-Value Problem**

Dumb-Bell Model

Two different Resonance Frequencies

$$\omega_1 = \frac{1}{\sqrt{L_1 C}}$$

Fixed Coupling $k = \frac{C}{C_k}$



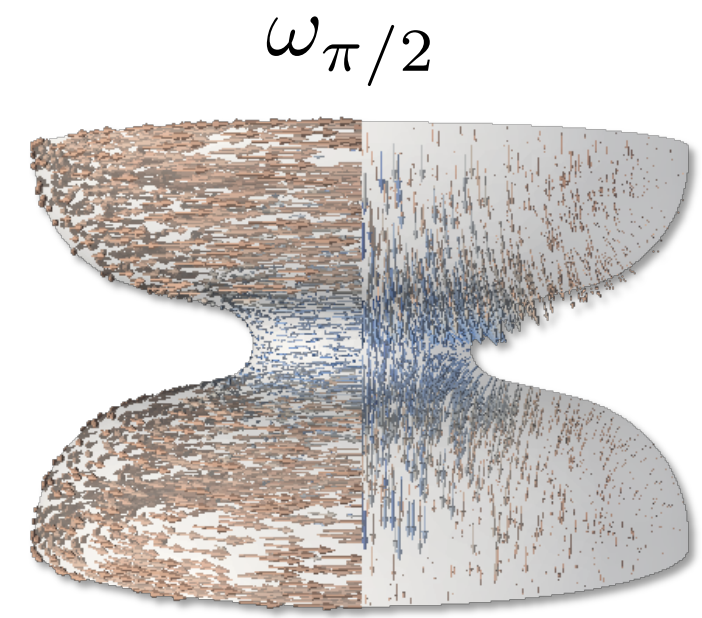
π/2-Mode

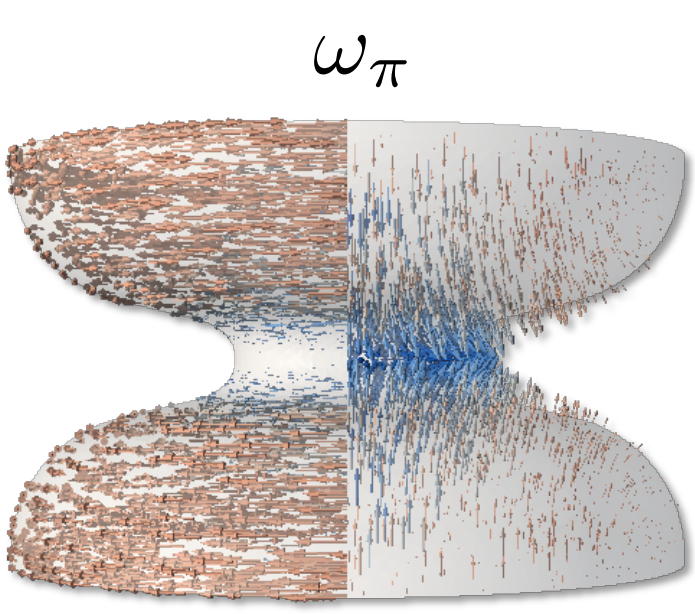
π-Mode

$$\omega_2 = \frac{1}{\sqrt{L_2 C}}$$

Quadratic **Eigen-Value Problem**

The Measurement Problem





ω_1

k

ω_2

three unknowns

High-Currents over “adverse” joints

Mathematical Solution

Eigen-Frequencies:

$$\omega_{\pi/2}^2 = \frac{1}{2}\left((1+k)\omega_1^2 + (1+k)\omega_2^2 - \sqrt{-4(1+2k)\omega_1^2\omega_2^2 + (1+k)^2\left(\omega_1^2+\omega_2^2\right)^2}\right)$$
$$\omega_{\pi}^2 = \frac{1}{2}\left((1+k)\omega_1^2 + (1+k)\omega_2^2 + \sqrt{-4(1+2k)\omega_1^2\omega_2^2 + (1+k)^2\left(\omega_1^2+\omega_2^2\right)^2}\right)$$

two knowns versus three unknowns ➔ undetermined

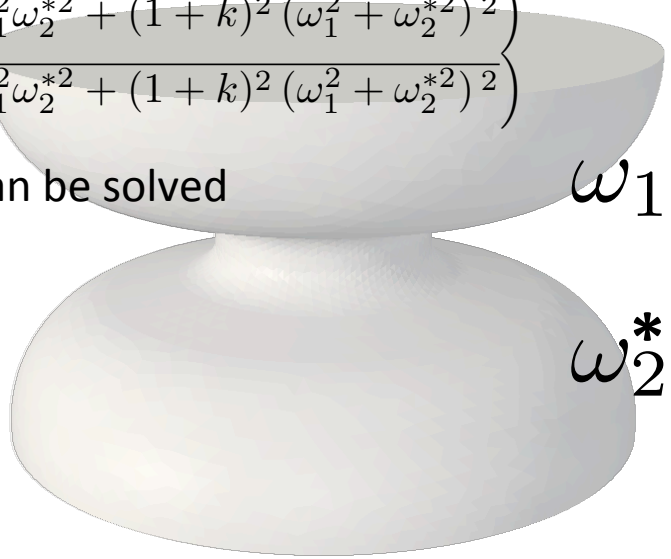
Introducing Perturbation (*k* = const.):

$$\omega_{\pi/2}^{*2} = \frac{1}{2}\left((1+k)\omega_1^2 + (1+k)\omega_2^{*2} - \sqrt{-4(1+2k)\omega_1^2\omega_2^{*2} + (1+k)^2\left(\omega_1^2+\omega_2^{*2}\right)^2}\right)$$
$$\omega_{\pi}^{*2} = \frac{1}{2}\left((1+k)\omega_1^2 + (1+k)\omega_2^{*2} + \sqrt{-4(1+2k)\omega_1^2\omega_2^{*2} + (1+k)^2\left(\omega_1^2+\omega_2^{*2}\right)^2}\right)$$

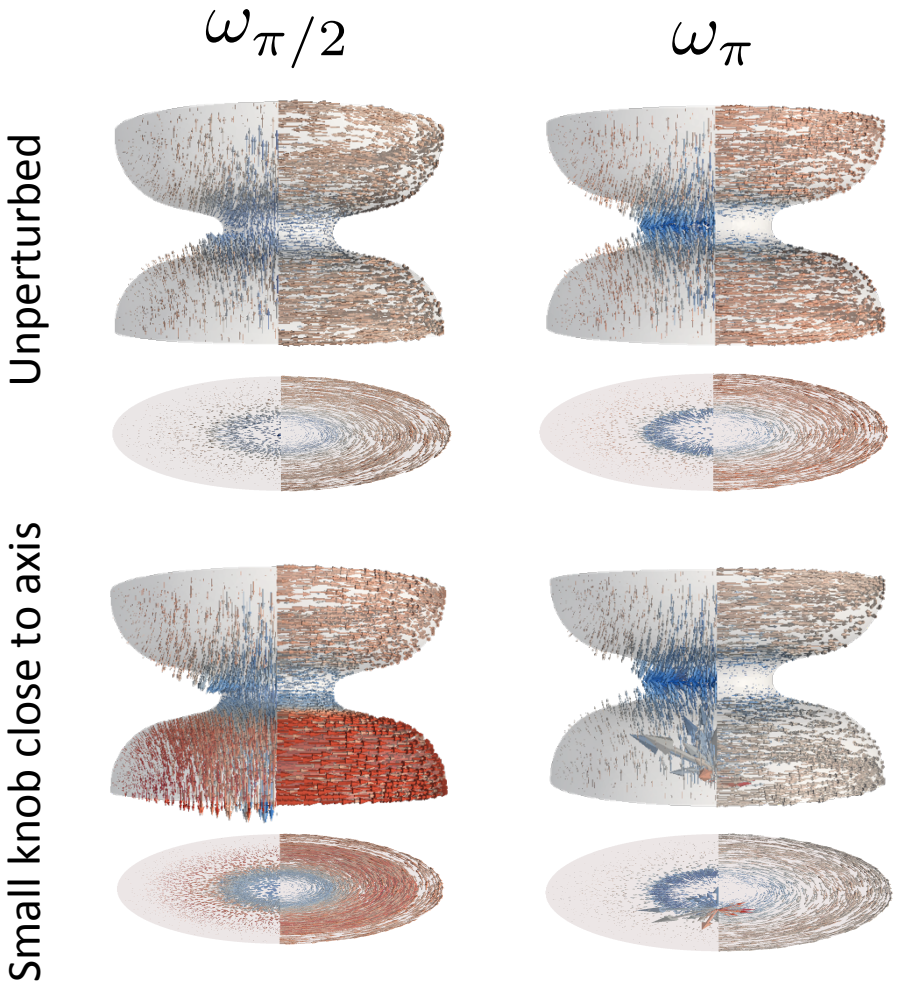
four knowns versus four unknowns ➔ can be solved

“Measurement” of:

$$\omega_1, \quad \omega_2, \quad k, \quad \text{and} \quad \omega_2^*$$



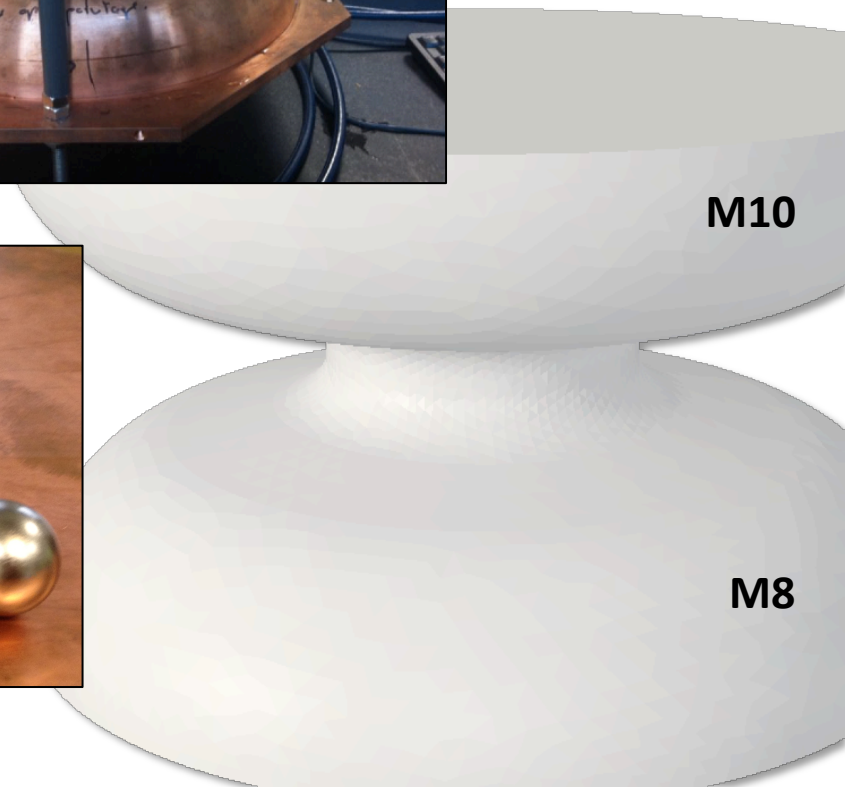
Simulation Results



Simulated with Omega3P

- Perturbation
  - No differences between “big” and “small” objects
  - Shift according to position
- Accuracy
  - 10E-4
- Two flavors of the same kind
  - Strong difference in π-Mode
  - No tuning on the iris

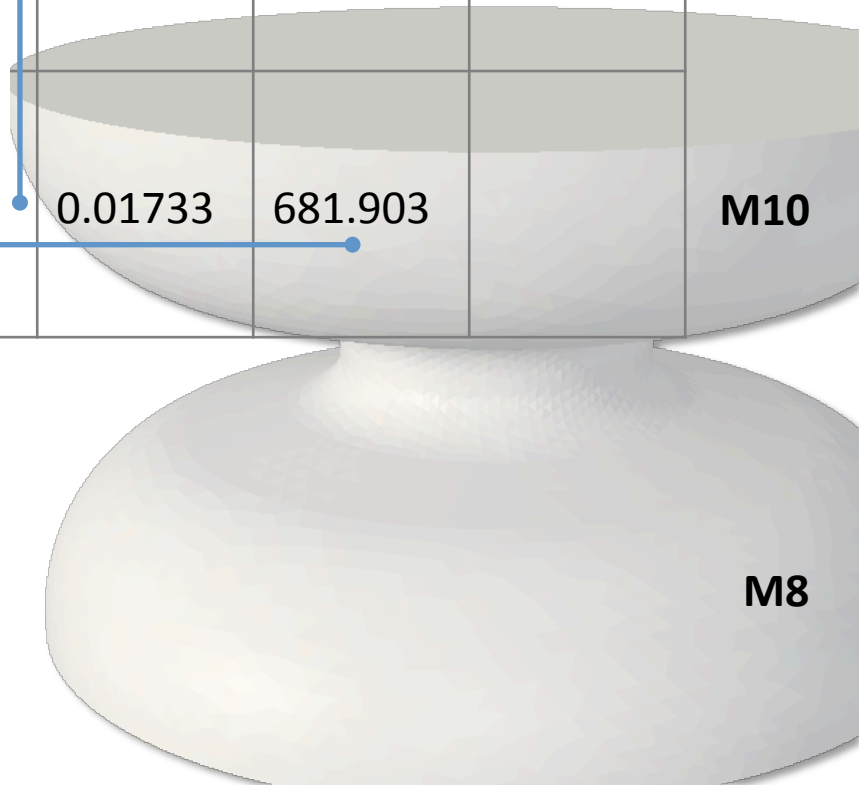
First Measurements



First Measurements

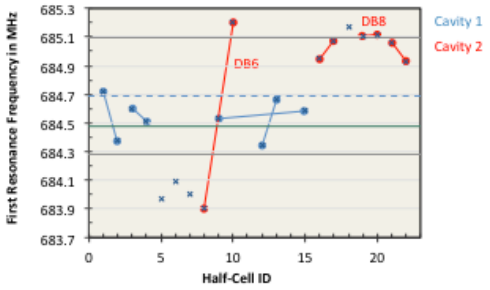
	$f_{\pi/2}$	f_{π}	f_{M8}	f_{M10}	k	f'_{M8}	f'_{M10}
U	683.666	695.550	683.112	684.279	0.01744		683.273
P10	683.192	695.010					
U	683.655	695.564					
P8	683.129	695.205	682.781	684.685	0.01733	681.903	

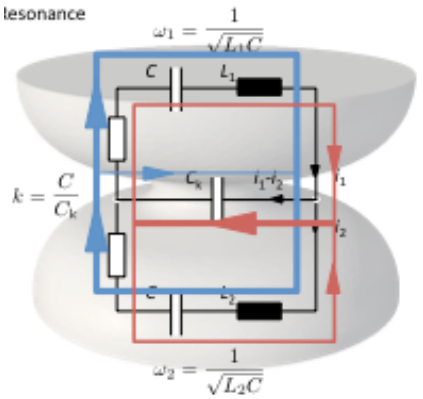
683.0 +/-0.17 **684.4** +/-0.30



Questions

- Half-cell to dumb-bell combination scheme
  - What are your experiences?
- Measurement Procedure
  - What accuracy can we expect?
  - What is the best perturbation object?
- Quadratic eigenvalue problem
  - Who has already addressed this kind of problem?





The End

Thank you for your attention!