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Ministero dell'Università e della Ricerca
Italiadomani PIANO NAZIONALE DI RIPRESA E RESILIENZA
INFN Istituto Nazionale di Fisica Nucleare

Hands-on Session: Calculation of the Loss Angle from Real Measurements of Free Oscillation Decay

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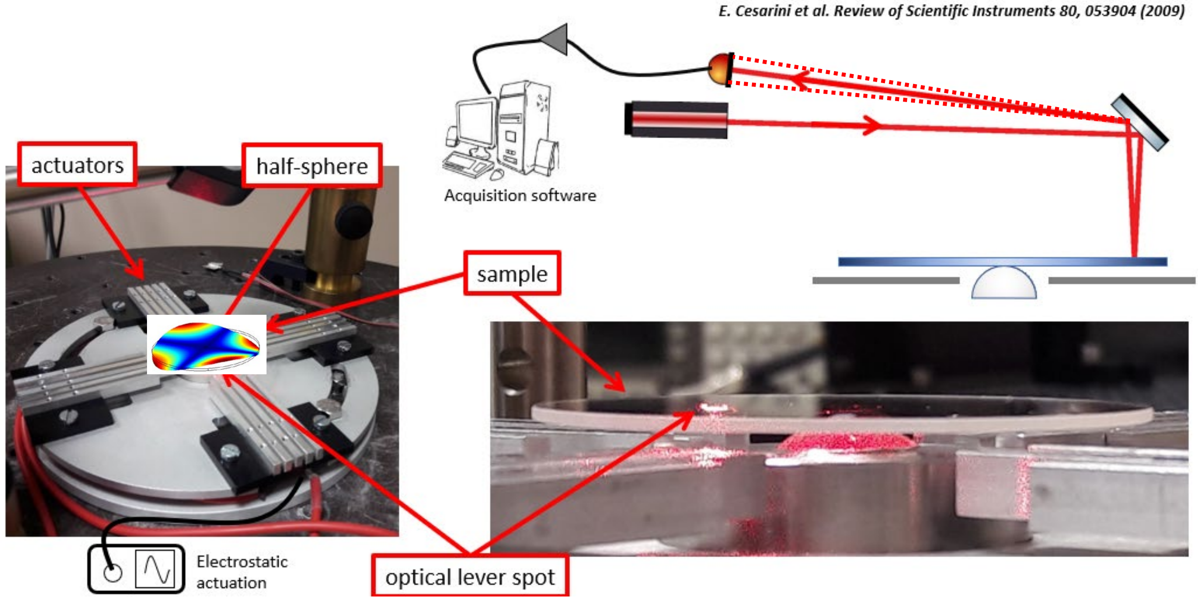
Loss Angle

Essential quantities to characterize the dissipative behaviour of materials:

- ***Quality factor*** $\boldsymbol{Q} \equiv 2\pi \frac{E_{tot}}{E_{diss}}$
  - Systems with high dissipations have low Q and larger off-resonance contribution, and viceversa
- A system is dissipative whenever its response to a step input is characterized by a finite *relaxation time* $\tau \rightarrow$ phase lag between input and response → ***Loss angle*** $\boldsymbol{\varphi(\omega)}$
  - At resonance $\varphi(\omega_0) = \frac{1}{Q}$
  - Additive quantity
- Any physical system can be composed by many different parts (i), whose stored energies (s) can be dissipated by many different mechanisms (m)
  - ***Dilution factor*** $\boldsymbol{D_{i,s}(\omega)} = \frac{E_{i,s}}{E_{tot}}$
  - $\varphi_{tot} = \sum_i \frac{E_{diss,i}}{2\pi E_{tot}} = \sum_i \sum_s D_{i,s}(\omega) \sum_m \varphi_{m,i}^s$

GeNS – schematic view



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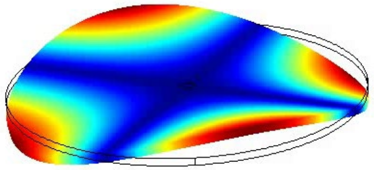
What to do?

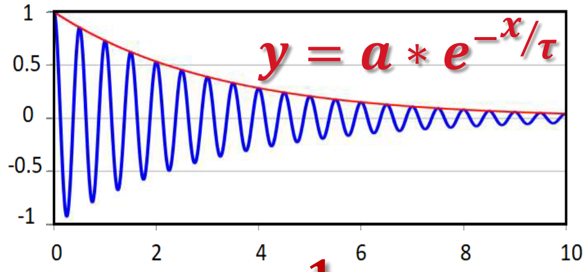
- **Access the measurements**: Download the real measurements of the decay of free oscillations from google drive link
- **Form groups**: Create up to 6 groups and assign each group one of the following files:
  - 5530, 12641, 21926, 33288, 33673, 46640
- **Understand the data format**: The data files contain two columns: two columns (time, amplitude)
- **Analyse the data**: Use your preferred software or computing platform to process the data.
  - **Calculate damping**: Compute the damping characteristic time (τ) of the free oscillations.
  - **Determine the loss angle**: Using the results, compute the loss angle (φ).

% Parametri fisici del campione (SiO2)
diam. = 25.4e-3; % Diametro in metri
thick. = 0.5e-3; % Spessore in metri
E = 72e9; % Modulo di Young (Pa)
rho = 2200; % Densità (kg/m^3)
nu = 0.17; % Coeff. di Poisson



```
0.000000        0.525265
1.031546        0.511635
2.058404        0.499978
3.082936        0.488008
4.109062        0.477650
5.136262        0.465633
   ⋮               ⋮
```

File name	$f_{measured}$
5530	5530,0078
12641	12641,375
21926	21926,609
33288	33288,125
33673	33673,4375
46640	46640,875



$$y = a * e^{-x/\tau}$$

$$\varphi = \frac{1}{\pi f \tau}$$

modo	frequenza	a	tau	phi
Top secret	5530,01	Top secret		Top secret
	12641,38			
	21926,61			
	33288,13			
	33673,44			
	46640,88			

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Resonant modes

mode m	mode n	File name	$f_{measured}$	$\phi_{measured}$
Top secret		5530	5530,0078	Top secret
		12641	12641,375	
		21926	21926,609	
		33288	33288,125	
		33673	33673,4375	
		46640	46640,875	

Use ResonantModes.m program to see the deformation shape of your mode!

Top secret

Top secret

Top secret

Top secret

Top secret

Top secret