Cartridge and tonearm systems resonance frequency

To maintain a cartridge/tonearm system resonance frequency within the acceptable range of 7 to 12 Hz, whereas 10 Hz recommended, it is necessary to choose a cartridge with the mass and compliance matching the tonearm

When selecting either MC or MM cartridges for your record player, total mass of tonearm (including cartridge and headshell) has to be taken into account in relation to the mechanical compliance (elasticity) of the cartridge cantilever system.

The high mass of the combination needs low mechanical compliance, otherwise record warps can easily provoke tonearm vibrations at frequencies around 4 to 6 Hz, that will bring degradation of performance (at least 8 Hz is advisable)

A phono cartridge with the compliance in the range of 5 to 10 µm/mN is considered as a very low compliance cartridge, a cartridge with the compliance in the range of 10 to 20 µm/mN is moderate compliance cartridge and a cartridge with the compliance value above 35µm/mN is very high compliance cartridge.

Low mass arms* mate well with both moderately high and very high compliance phono cartridges.
*A tonearm whose effective mass is rated at 10 grams or below is considered low mass (e.g. early SME's, Grace 747).
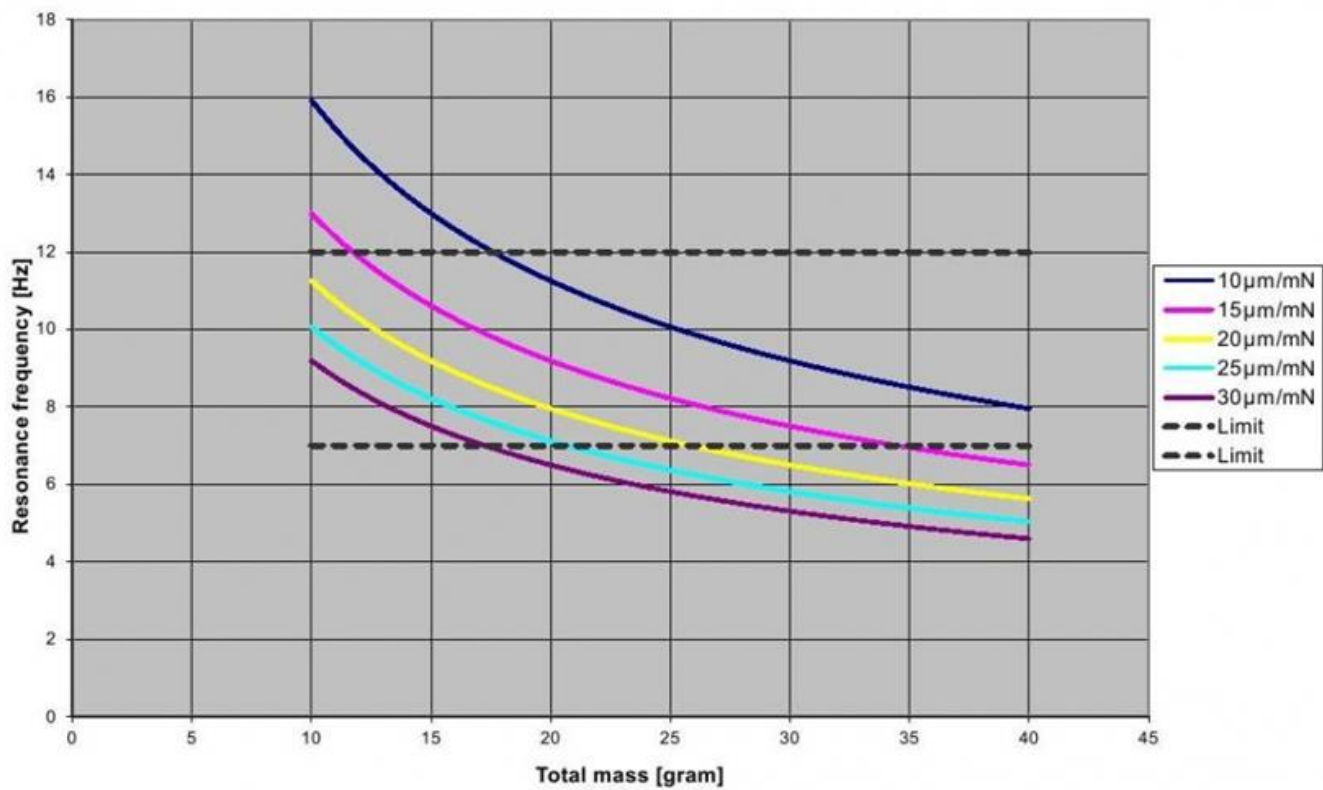
Moderate mass tonearms** are good companions for moderate to low compliance cartridges.
**A tonearm whose effective mass is rated between 11 and 25 grams is considered moderate mass (e.g. SME 309, IV, IV-VI, V, Triplanar, Graham). Arms above 25 grams of mass are high mass in nature (Eminent Technology, Dynavector).

If a low compliance cartridge is used with a low mass tonearm, undesirable resonances can occur in the audible range. Mistracking may also be a problem.

When a high compliance cartridge is mated with a moderate mass tonearm, resonances in the infrasonic range may occur in addition to some unwanted high frequency damping.

The below diagram illustrates the relationship between cartridge compliance, tonearm mass and the resulting resonance frequency.

Resonance frequency can be calculated by using the formula

$f = 1000 : (2 \times \pi \times \sqrt{(M \times C)})$ where:

f - Cartridge resonance frequency in Hz

π - 3.14159265359...

C - Cartridge compliance lateral in μm/mN

M - Total tonearm system mass which is a sum of Mass of cartridge, Mass of headshell and screws and Effective mass of tone arm (all values in gram).

• Resonance frequency within 7-12Hz is optimal for the system.

• Resonance frequency slightly outside optimal interval 6,5-7Hz and 12-14Hz can be considered as a possible that probably can be used without problems.

• Resonance frequency outside the interval 6,5-7Hz and 12-14Hz is questionable, and the system might not work properly.