Advantage of cryogenic interferometer

(thermal noise of mirror)

(1) Loss of substrate

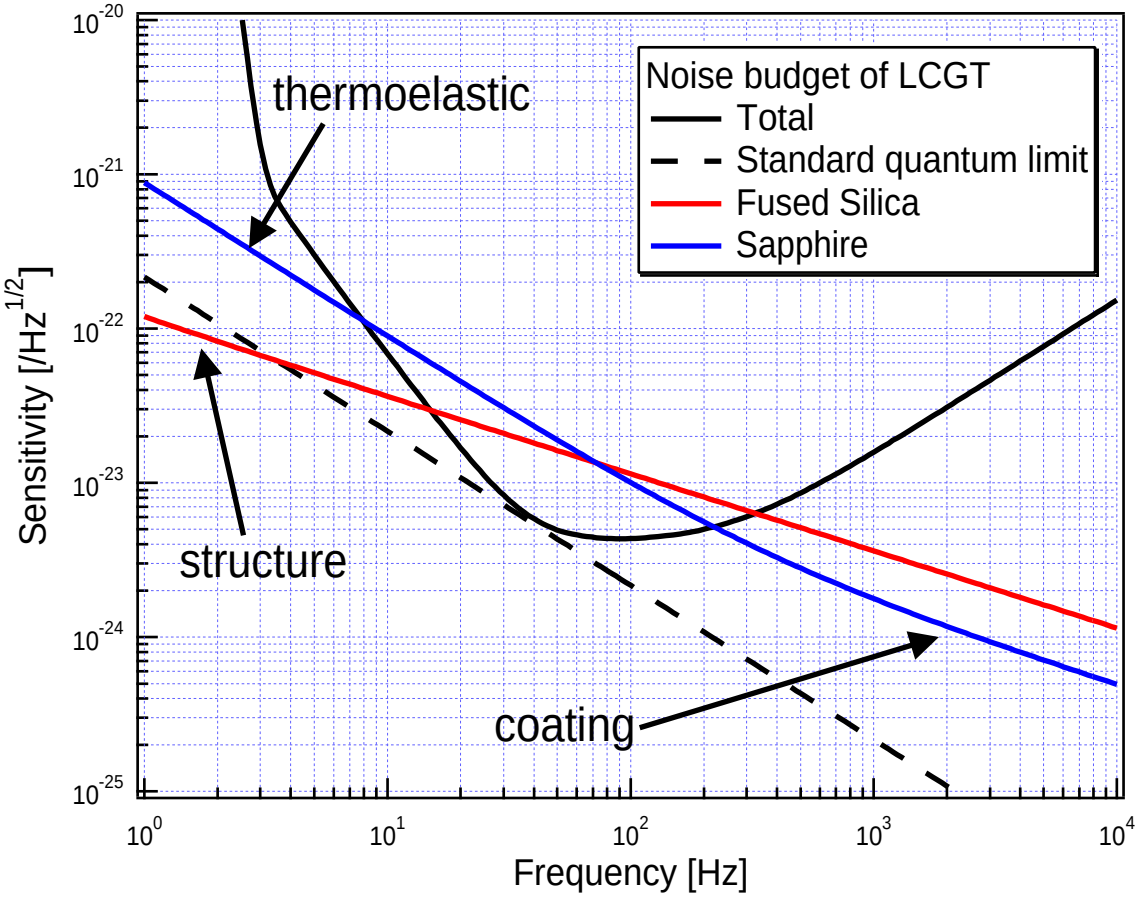
(i) Structure damping : $f^{-1/2}$

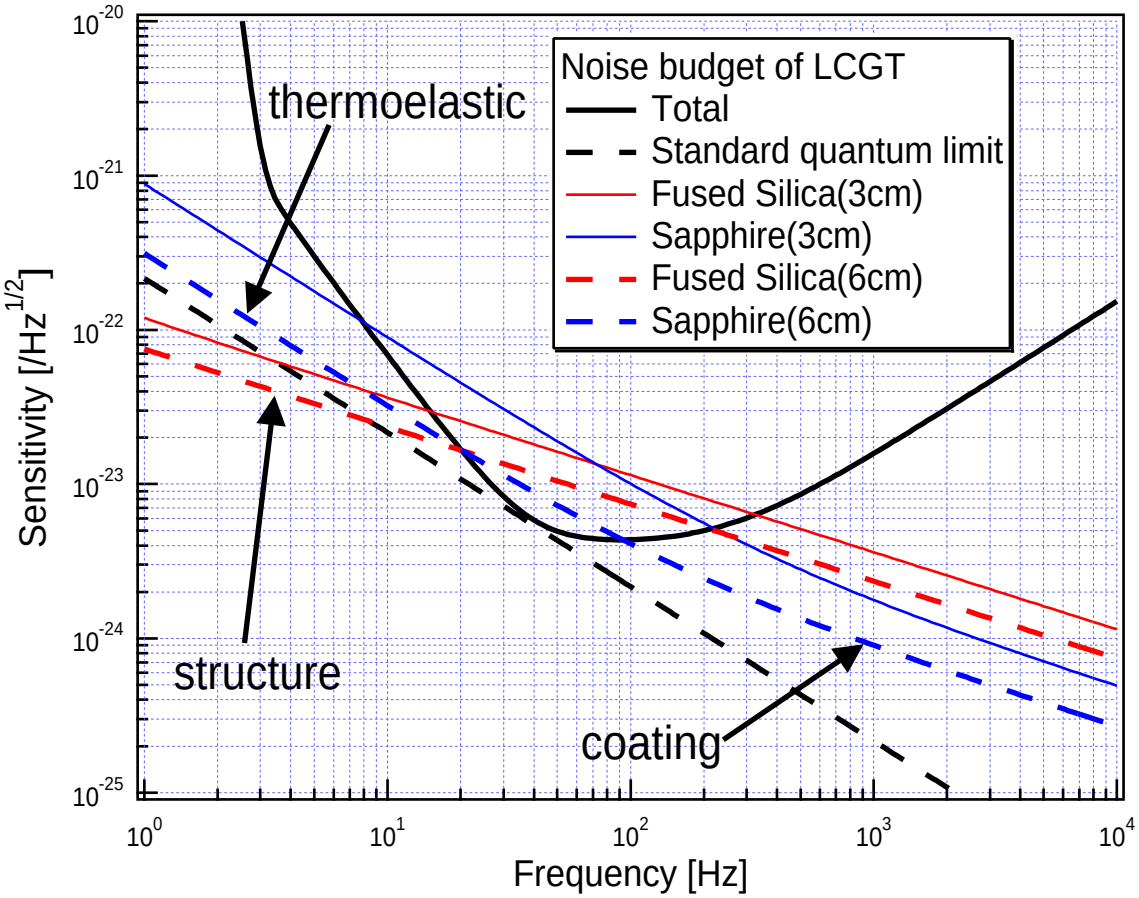
$Q=3*10^{7}$ (fused silica) $Q=1*10^{8}$ (sapphire)

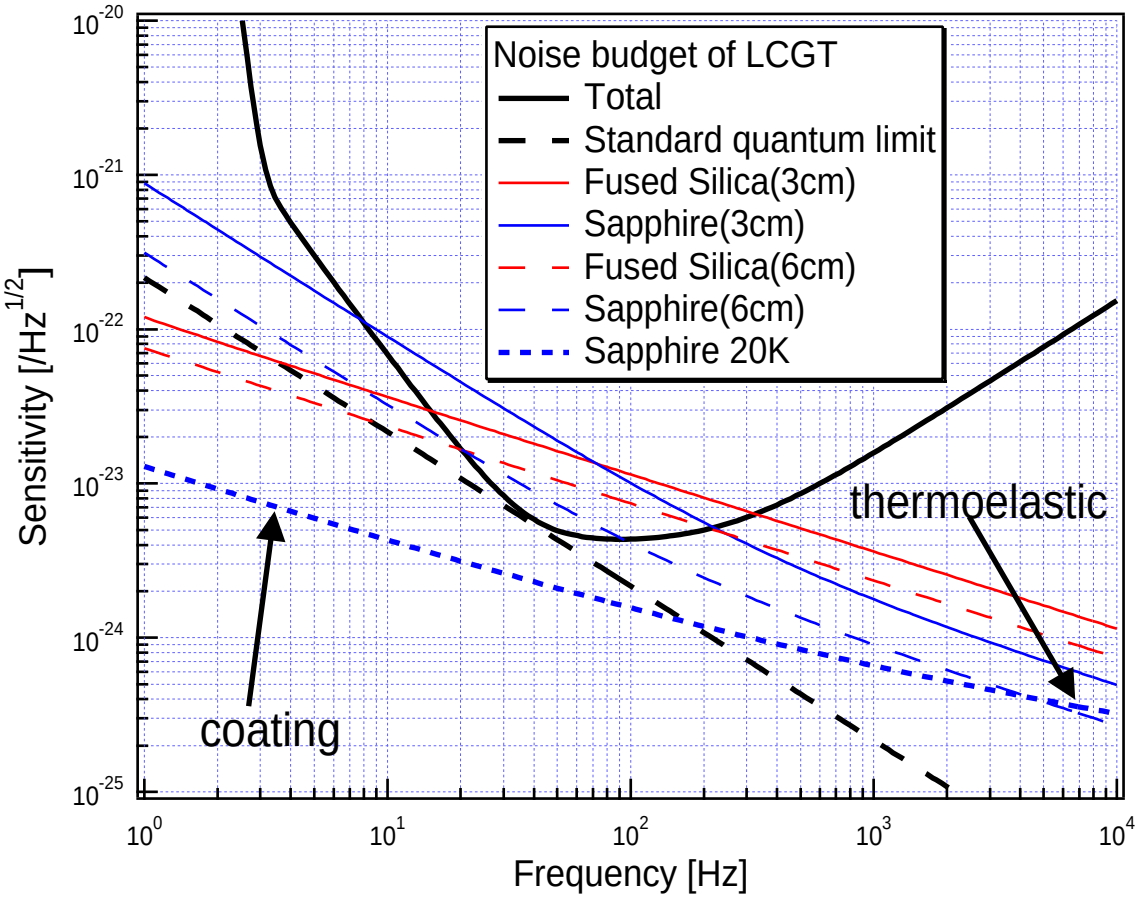
(ii) Thermoelastic damping: f^{-1} (room temperature)
$f^{-1/4}$ (low temperature)

(2) Loss of reflective coating

Structure damping : $f^{-1/2}$ $f=10^{-4}$


Noise budget of LCGT
Total
Standard quantum limit
Fused Silica
Sapphire
thermoelastic
structure
coating
Sensitivity [/Hz^1/2]
Frequency [Hz]
10^-20
10^-21
10^-22
10^-23
10^-24
10^-25
10^0
10^1
10^2
10^3
10^4


Noise budget of LCGT
Total
Standard quantum limit
Fused Silica(3cm)
Sapphire(3cm)
Fused Silica(6cm)
Sapphire(6cm)
thermoelastic
structure
coating
Sensitivity [/Hz^1/2]
Frequency [Hz]
10^-20
10^-21
10^-22
10^-23
10^-24
10^-25
10^0
10^1
10^2
10^3
10^4



(LIGO I)>(LIGO II)>(SQL)>(LCGT)

Thermoelastic damping

(1) T : 300K ⟶ 20K 1/9

(2) r : 3cm ⟶ 6cm 1/3

Coating loss

(1) T : 300K ⟶ 20K 1/4

(2) f : 10^{-4} ⟶ 10^{-5} 1/3

(3) r : 3cm ⟶ 6cm 1/2

Structure damping

(1) T : 300K ⟶ 20K 1/4

(2) r : 3cm ⟶ 6cm 1/1.4

Too cool ?

S/N (Binary coalescence)

(1) improvement of bottom

S/N : 1.4 times larger ??? → check !

(2) higher frequency

bottom sensitivity : 4 times larger

S/N : 2 times larger than Ad. LIGO ? → check !

high power → possible ?

(3) SQL suppression ??? large mirror → possible ?

(4) detune ???