STACKED DOUBLET COATING THICKNESS OPTIMIZATION INCLUDING THERMOOPTIC NOISE

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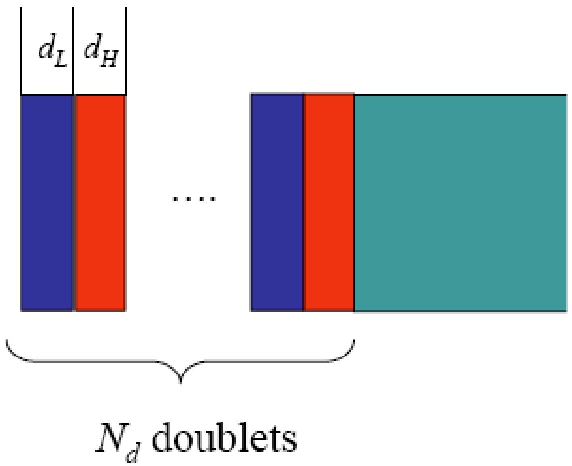
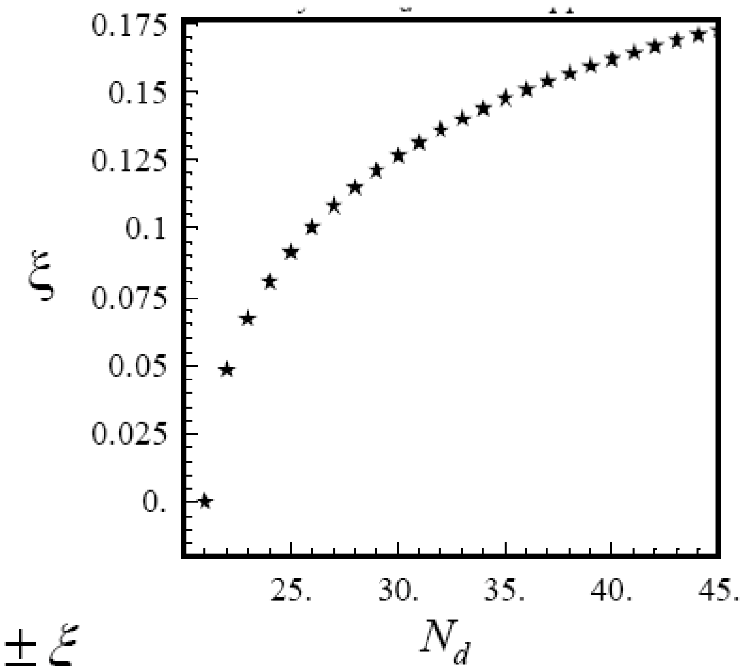
SiO_2-Ta_2O_5 Stacked Doublet Designs, τ = 0.973 ppm





$$z_{L,H} = \left(\frac{n_{L,H}}{\lambda_0}\right) d_{L,H}, \qquad z_{L,H} = \frac{1}{4} \pm \xi$$

All calculated for 1 ppm transmission

ξ= deviation from $1/4\lambda$

Thermo Optic Displacement Noise PSD

Thermo-elastic coefficient

Thermo-optic coefficient

$$coherent = \left(\frac{\Delta x^{(E)}}{\Delta T} + \frac{\Delta x^{(R)}}{\Delta T} \right)^2 S_{\Delta T}(f)$$

PSD of thermal fluctuations

$$incoherent = \left[\left(\frac{\Delta x^{(E)}}{\Delta T} \right)^2 + \left(\frac{\Delta x^{(R)}}{\Delta T} \right)^2 \right] S_{\Delta T}(f)$$

$$S_{\Delta T}(f) = \left(\frac{1}{\pi f \kappa C \rho} \right)^{1/2} \frac{kT^2}{\pi r_0^2}$$

beam spot radius

Thermal conductivity

Specific heat capacity

Mass density

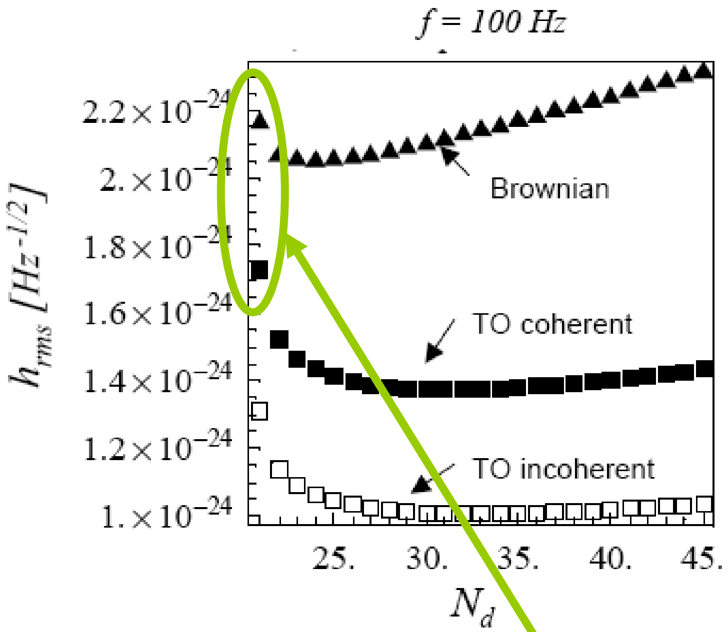
All parameters from BENCH

$\beta_{Tantala} = 6 \cdot 10^{-5}$ (*Gretarsson*, 2007)

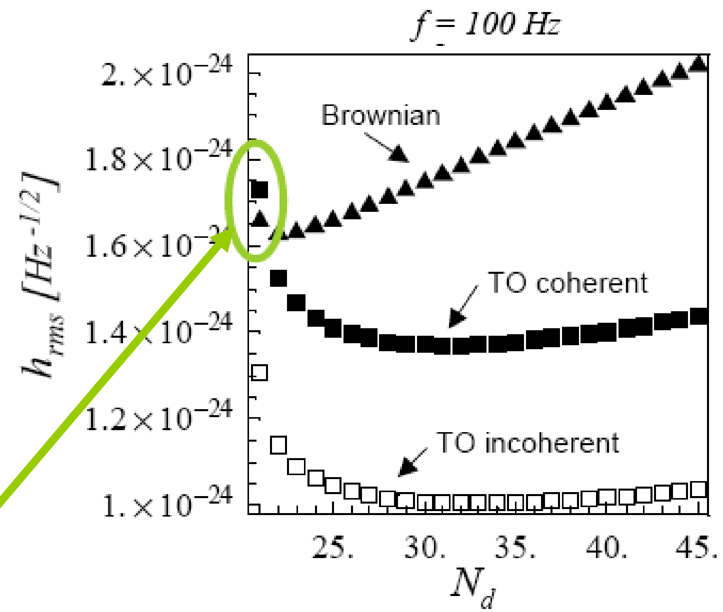
$\phi_{Silica} = 5 \cdot 10^{-5}$, $\phi_{Tantala} = 3 \cdot 10^{-4}$ (*LMA*, 2006)

Effects of Thermo Optic Noise individual contributions

- Plain tantala



Doped tantala

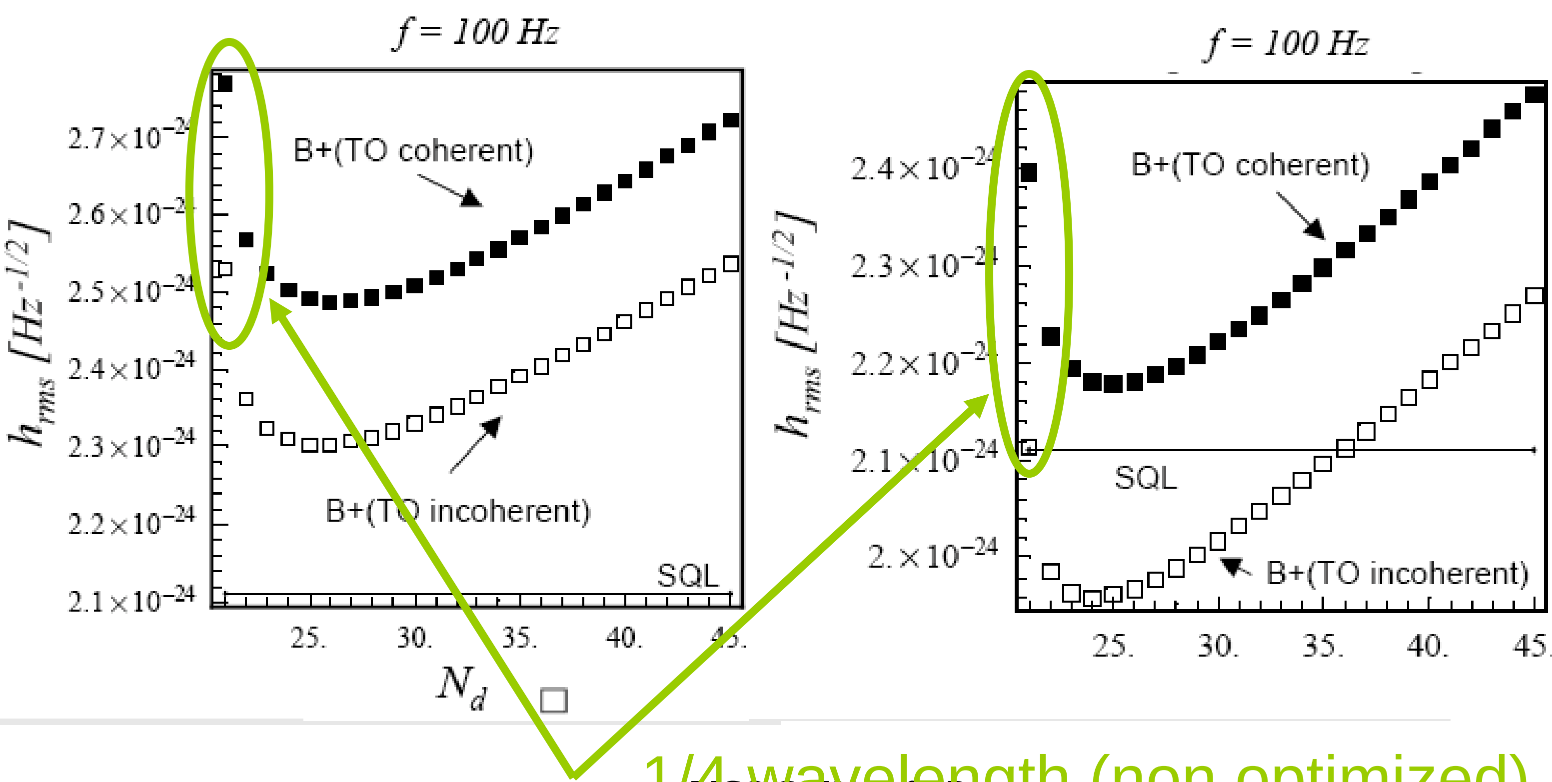


1/4 wavelength (non optimized)

Effects of Thermo Optic Noise
sum of contributions

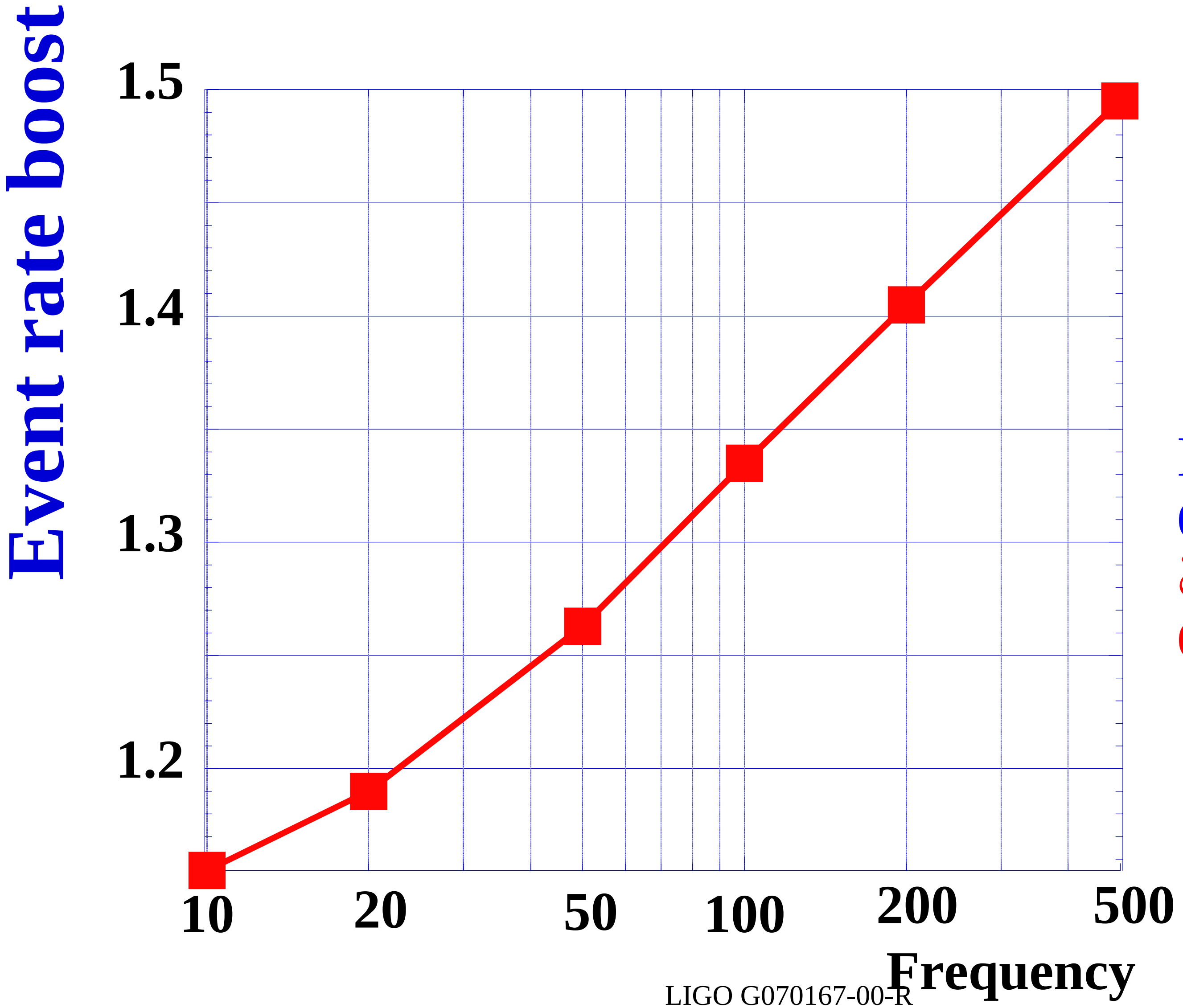
- Plain tantala

Doped tantala



1/4 wavelength (non optimized)

Gain from Optimization



N_d=25
(instead of 21)

ξ=0.075
(deviation from 0.25)

Conclusions

Doublet thickness optimization is effective for minimizing *total* (Brownian + Thermooptic) coating noise.

When using doped Tantala:

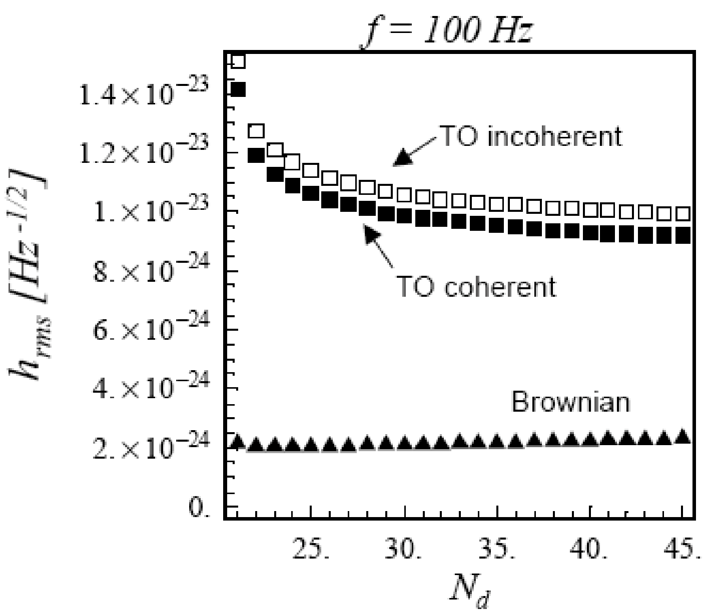
-Thermooptic noise vanifies Brownian noise reduction, if the plain QWL design is used;

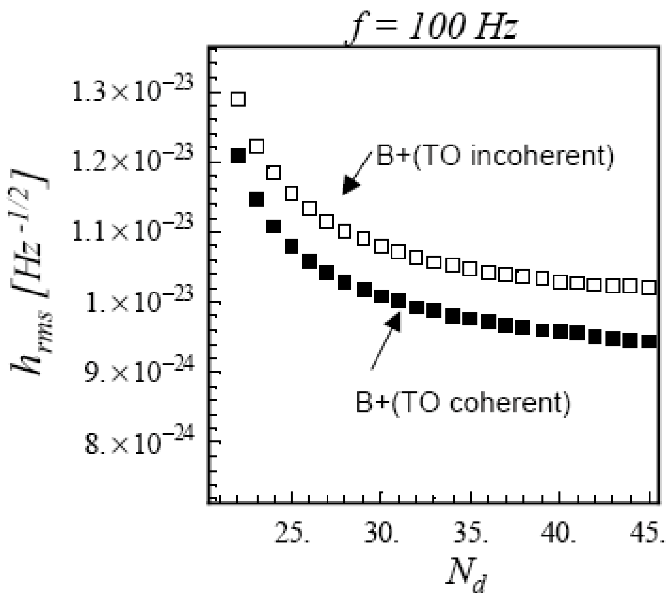
-Doublet thickness optimization is still in order, and yields sensible (30% ave) event rate boost;

-Measurements of α, β for doped Tantala needed!

appendix

Doublet Optimization. Plain Tantala. Inci's Numbers





All parameters from BENCH

$$\alpha_{Tantala} = -4.4\cdot10^{-5}, \beta_{Tantala} = 1.2\cdot10^{-4}\,(Inci,\ 2000)$$

$$\phi_{Silica} = 5\cdot10^{-5},\ \phi_{Tantala} = 1.5\cdot10^{-4}\,(LMA,\ 2006)$$