Issues with LIGO III Blue

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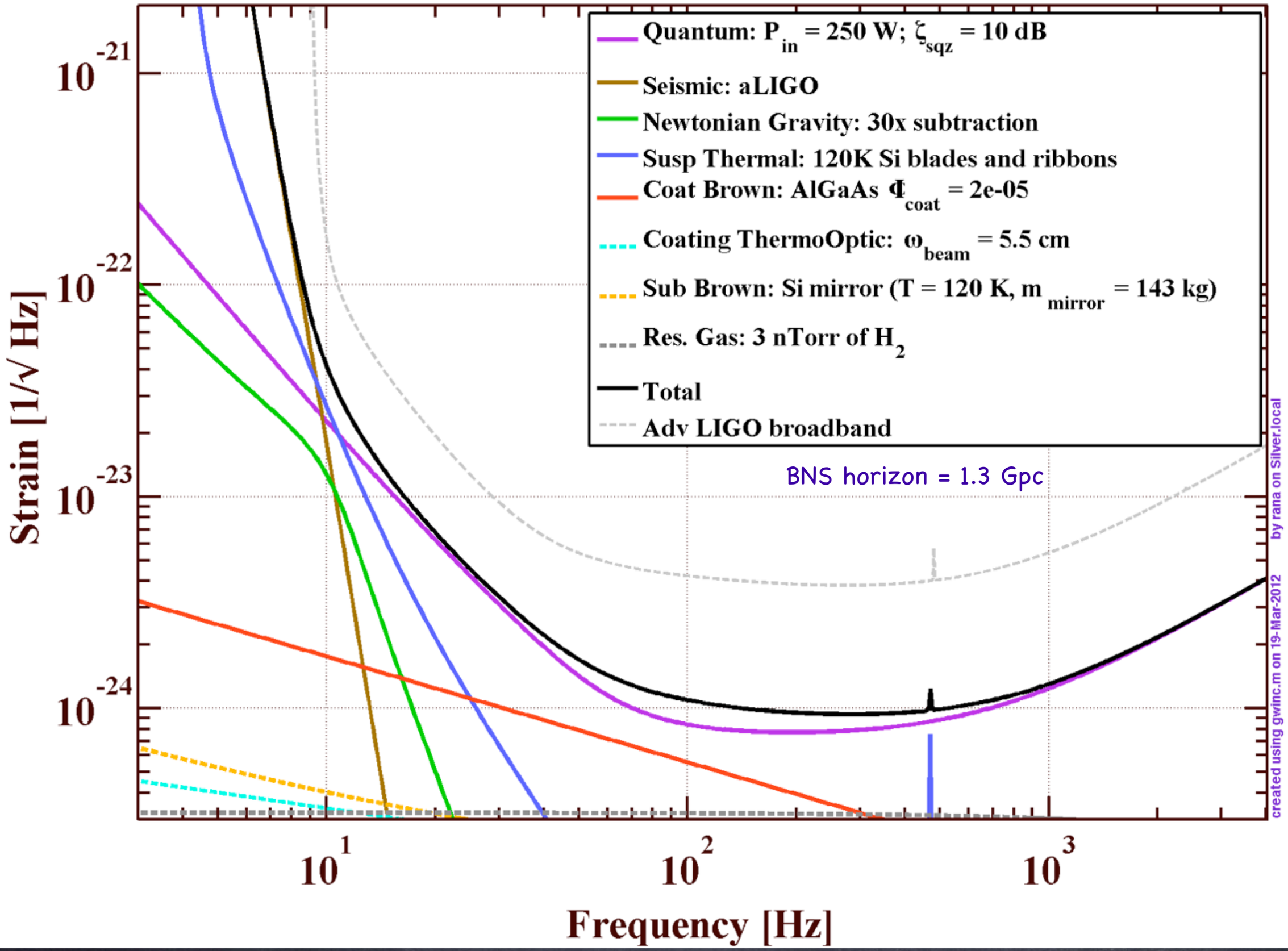
GWADW Elba May 2013

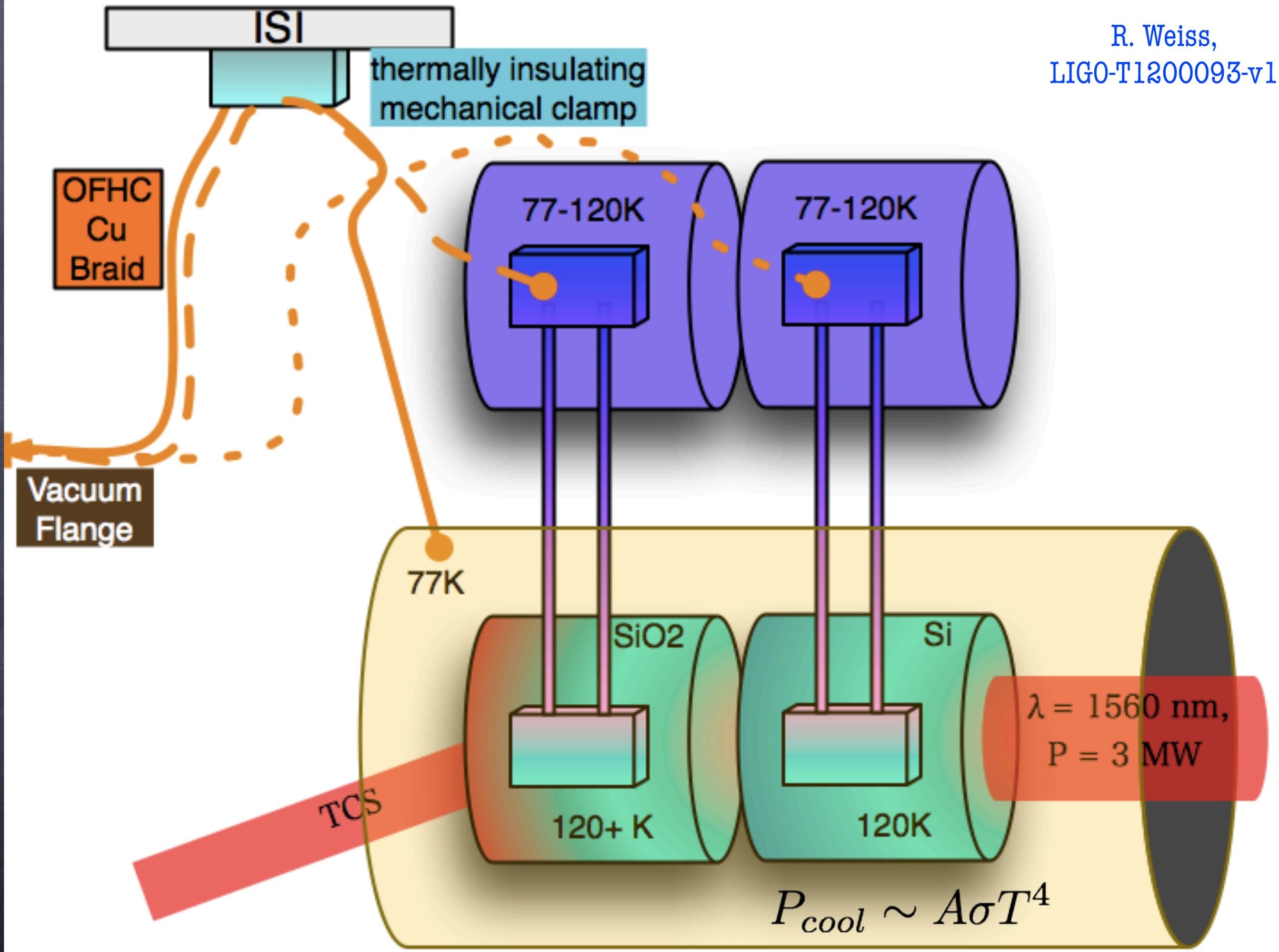
G1300XXX-v1


Quantum: P in = 250 W; ζ sqz = 10 dB
Seismic: aLIGO
Newtonian Gravity: 30x subtraction
Susp Thermal: 120K Si blades and ribbons
Coat Brown: AlGaAs Φ coat = 2e-05
Coating ThermoOptic: ω beam = 5.5 cm
Sub Brown: Si mirror (T = 120 K, m mirror = 143 kg)
Res. Gas: 3 nTorr of H 2
Total
Adv LIGO broadband
BNS horizon = 1.3 Gpc
Strain [1/√ Hz]
10 -21
10 -22
10 -23
10 -24
10 1
10 2
10 3
Frequency [Hz]
created using gwinc.m on 19-Mar-2012 by rana on Silver.local

Design Elements

- FD Squeezing Input is the winner
- Coatings: Probably GaP or GaAs
- Quad SUS w/ Si ribbons on last stage
- 120-160 kg mass: Si @ 117-125 K
- Si: High power (2-3 MW in arms)
- 1555-2222 nm laser; P_{laser} = 444 W
- 10-30x Newtonian Noise sub.

R. Weiss,
LIGO-T1200093-v1



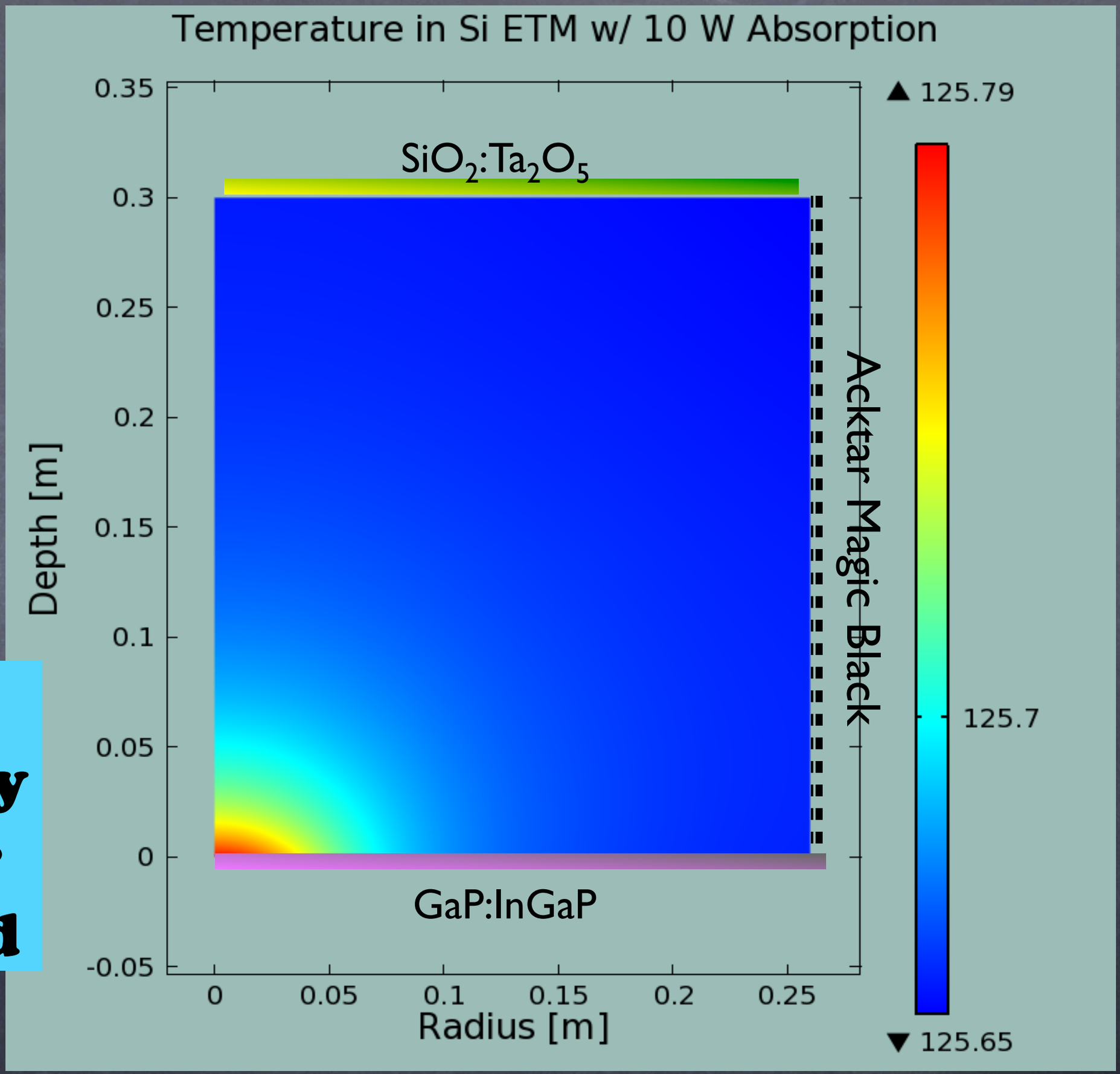
$$\sigma_{SiO_2:Ta_2O_5} \simeq 0.75$$

$$\sigma_{Si} \simeq 0$$

$$\sigma_{GaAs:AlGaAs} \simeq 0.75$$

$$\sigma_{magic} \simeq 1$$

Radiative Cooling Only i.e. no fiber cooling reqd



Juicy Research Opportunities

- Develop Si ribbons & blades
- Need reliable Absorption meas. @ 1500-2000 nm @ 120 K
- AlGaX coatings on Silicon are unproven
- Develop a 500 W laser at 1500-2000 nm
- Cryogenics for 77-130 K
- Si: High power (3 MW in arms)
- 30x Newtonian Noise subtraction

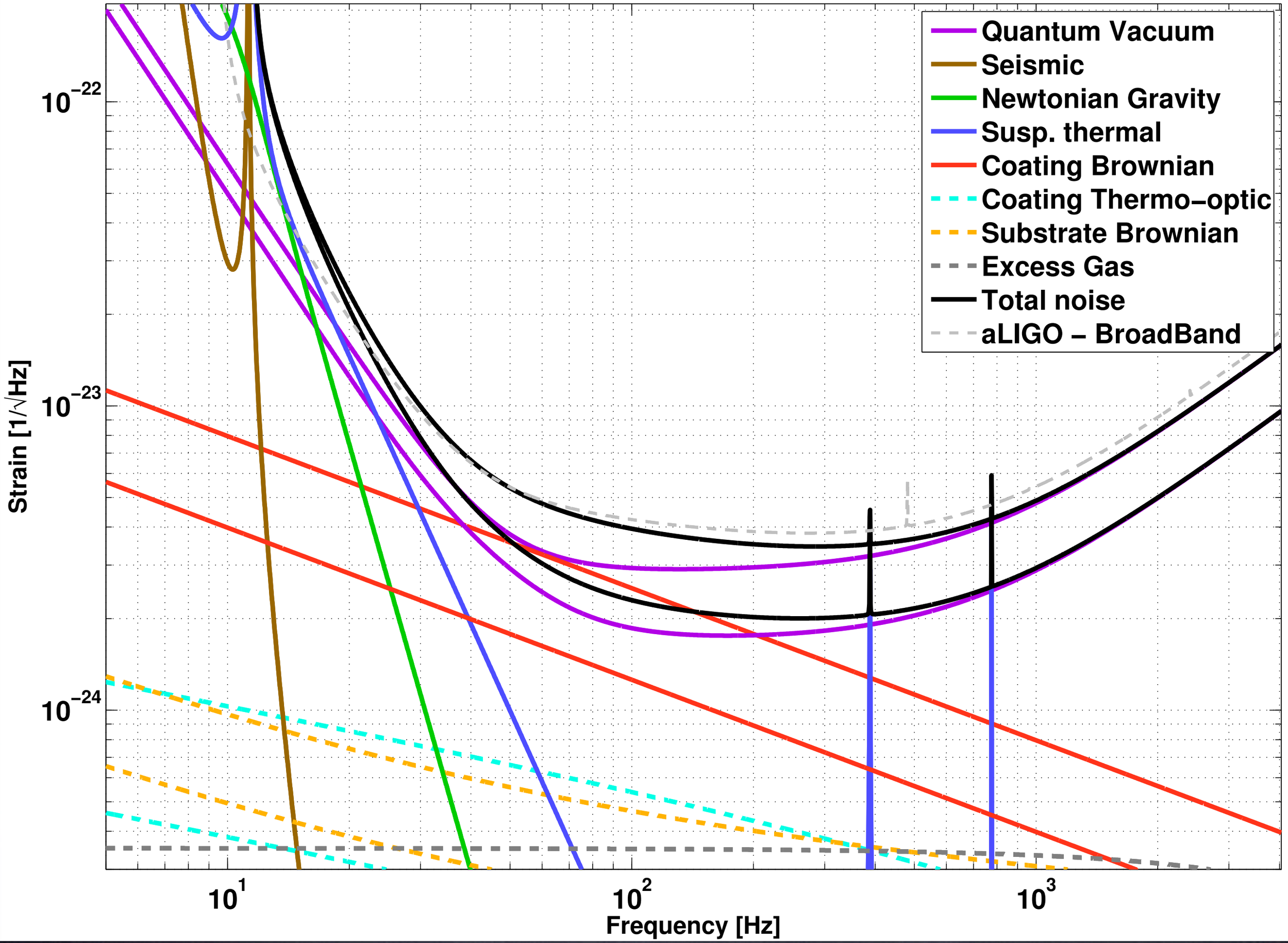
Thermal Lensing

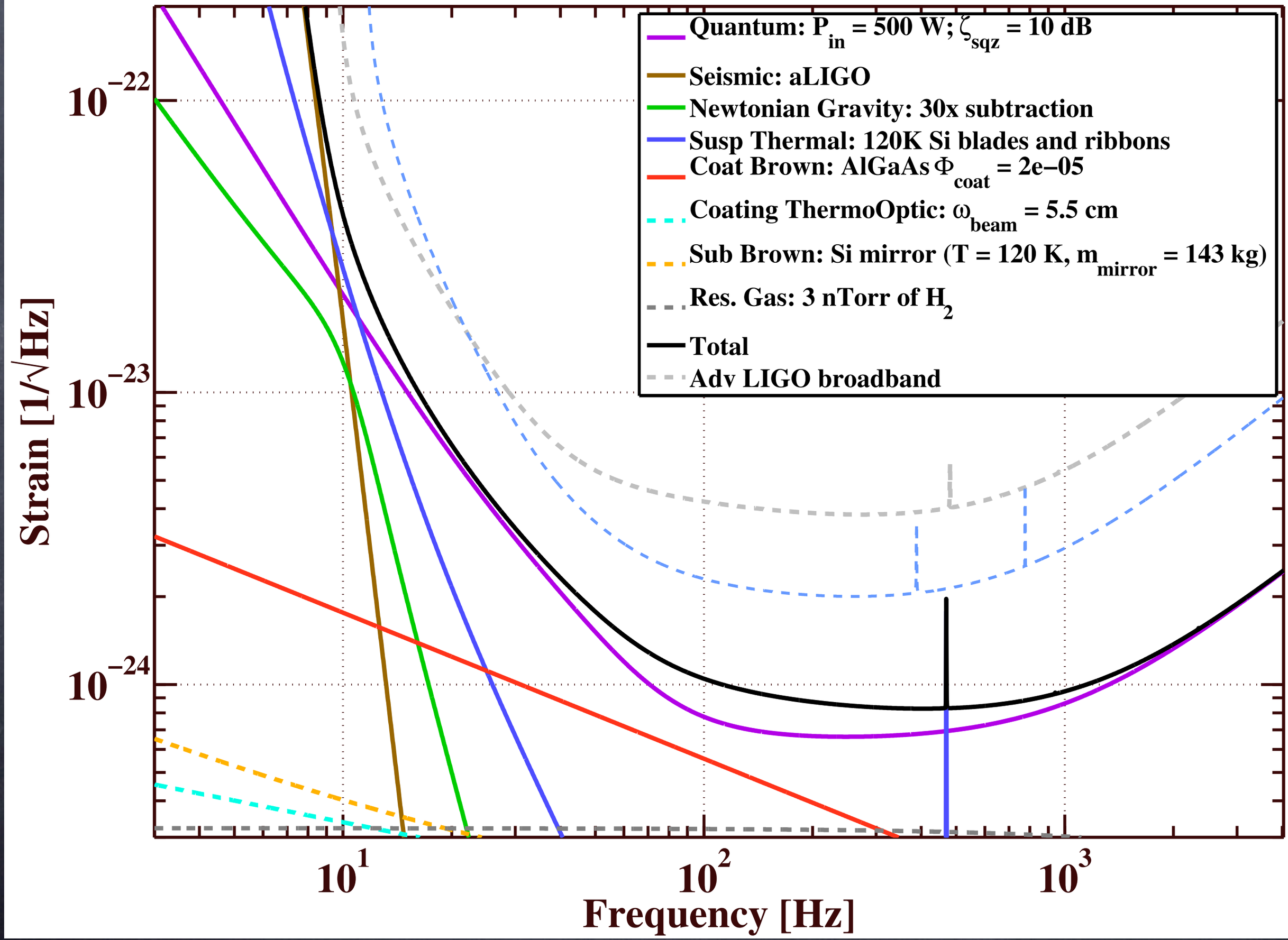
- Can LIGO/Virgo make it to full power? (my guess is no). We will <u>need</u> FI squeezing to get the baseline sensitivity.
- Possibilities: reduce contamination below 1 ppm, radically better TCS technology, or cryogenics.
- Advantage of cyrogenic Si over 300 K SiO2 is elimination of TCS system.

Moving the Goal Posts

- LIGO will be upgraded incrementally (of course).
- **Very** likely: Squeezing, then Filter Cavity, then crystal coatings (if absorption < 3 ppm)
- ALL 3G LIGO upgrades must be judged relative to this upgraded level.

Likely Intermediate upgrade to aLIGO




Quantum: P_in = 500 W; ζ_sqz = 10 dB
Seismic: aLIGO
Newtonian Gravity: 30x subtraction
Susp Thermal: 120K Si blades and ribbons
Coat Brown: AlGaAs Φ_coat = 2e−05
Coating ThermoOptic: ω_beam = 5.5 cm
Sub Brown: Si mirror (T = 120 K, m_mirror = 143 kg)
Res. Gas: 3 nTorr of H2
Total
Adv LIGO broadband
Strain [1/√Hz]
10^−22
10^−23
10^−24
10^1
10^2
10^3
Frequency [Hz]

Biggest Blue Issues

- Absorption in Si mass: bulk absorption from 2-photon -> FC, high FC lifetime in FZ Si, need high purity for high Q??
- Cryogenic heat shields without increasing backscatter
- Low phase noise with Silicon
- Cryo SUS prototype to explore issues (see Nic S. talk)

Is all this a Fantasy?

- People say, "There can be no 3G before detection". Bull. We start pre-detection.

Is all this a Fantasy?

- People say, "There can be no 3G before detection". Bull. We start pre-detection.
- "Once the people have decided in which direction to focus their will power, the rest is technical details."