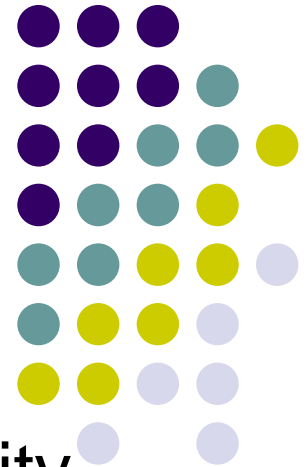


Issues and approaches for LCGT

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Motivation-features of LCGT

- LCGT is cryogenic, underground GW detector
- Unique feature comes with unique problems
 - Tunnel tilting
 - Thick suspension fiber
 - Smaller test mass
 - Limitation of laser power due to cryogenic.
- **Parameters are carefully chosen not to let these problems ruin the sensitivity.**



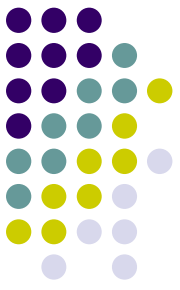
Risk management and future upgrade

- Parameters are carefully chosen not to let these problems ruin the sensitivity.
1. **Risk management**
 - What if vertical motion increases?
 - What if heat absorption is higher?
 2. **Future upgrade**
 - How can we improve the sensitivity?

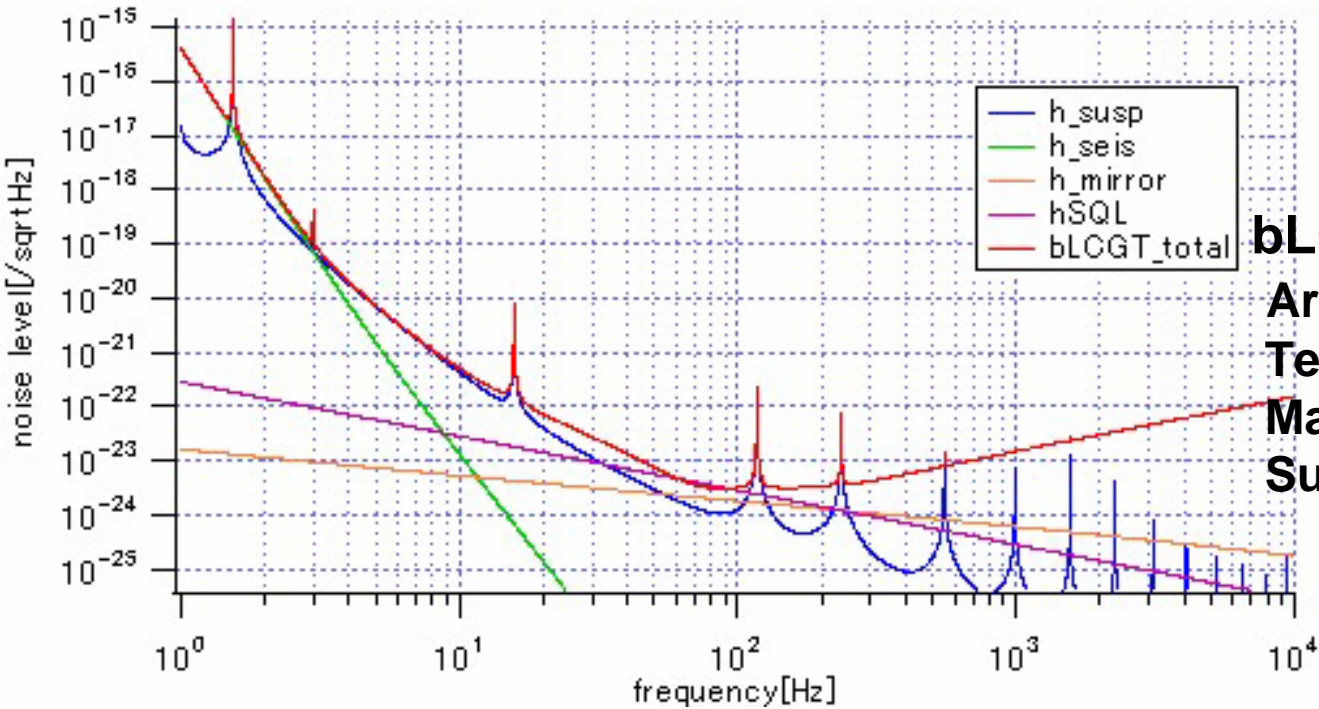


List of issues

1. There are some peaks above 100Hz
 - Those depends on the fiber being thick and tunnel tilting.
2. Radiation pressure noise
 - Sapphire test mass is small.
3. Shot noise
 - Limitation of laser power required from input laser.



bLCGT design sensitivity



bLCGT default parameters

Arm length: 3000[m]

Test mass: 30[kg]

Mass temperature: 20[K]

Suspension length: 0.3[m]

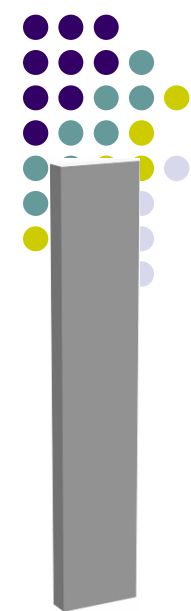
- Vertical mode at 120Hz, violin mode above 230Hz.
- Peak frequencies depend on suspension cross-section.

Moving 120Hz peak by changing the fiber shape

Peak freq $\propto 1/\text{cross-section}$

TN floor level $\propto \text{cross-section}$

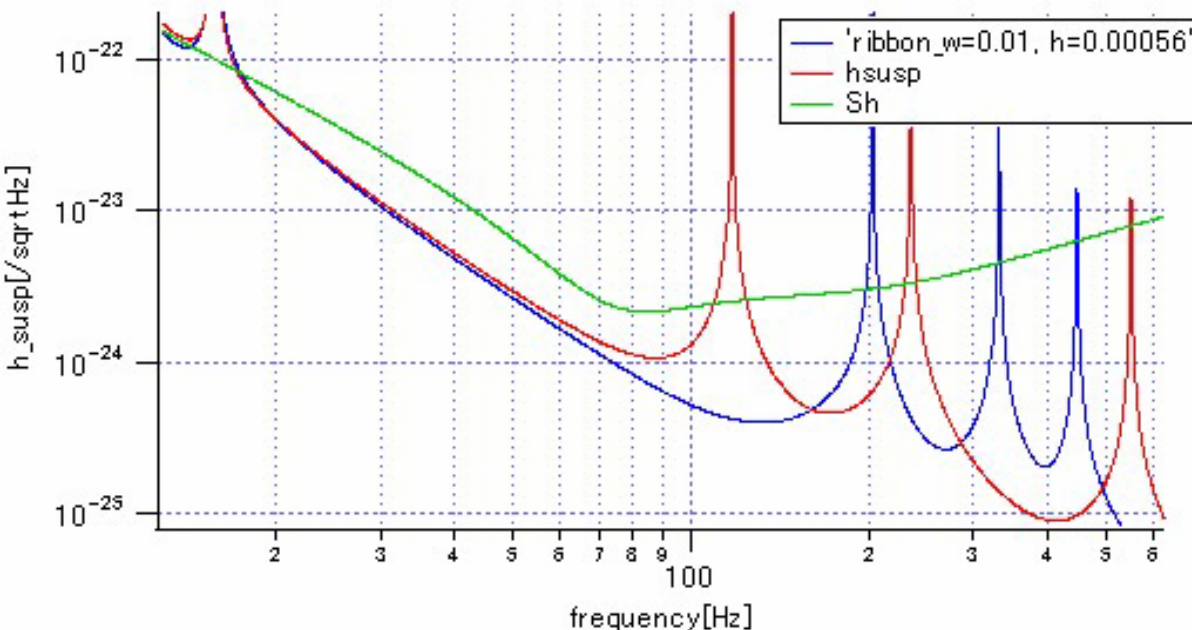
Heat flow also depends on cross-section



Thin fiber

Thick fiber

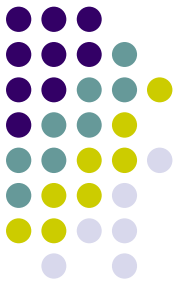
Ribbon



An alternative suspension

~ non-uniform fiber
short top + thick body

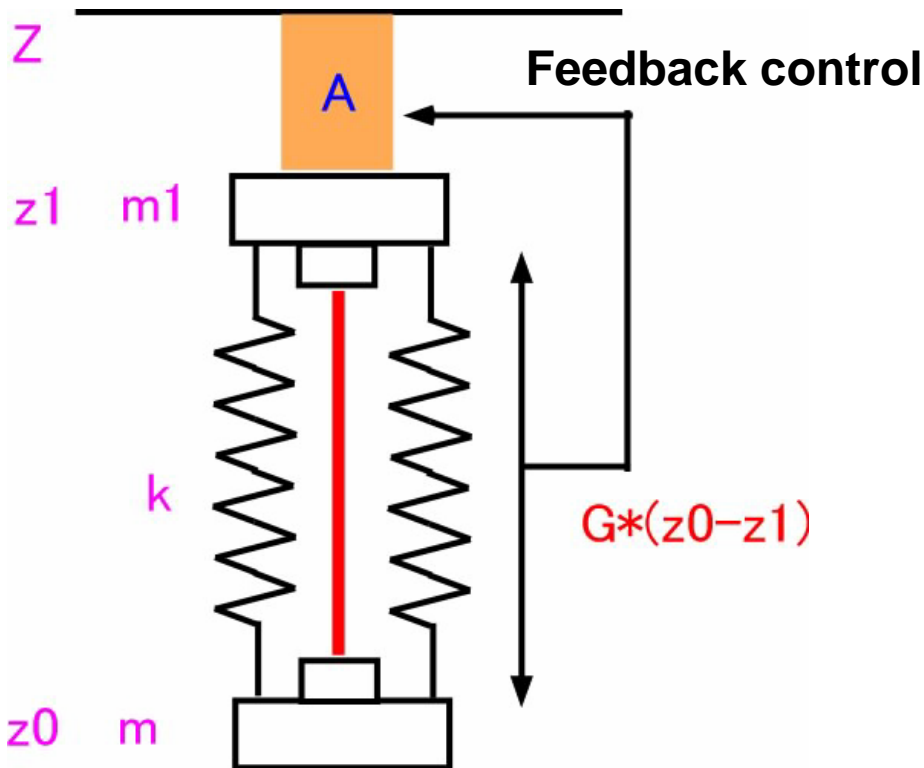




VSPI for vertical mode

- Vertical mode could be suppressed by VSPI.

[Vertical Suspension Point Interferometer]

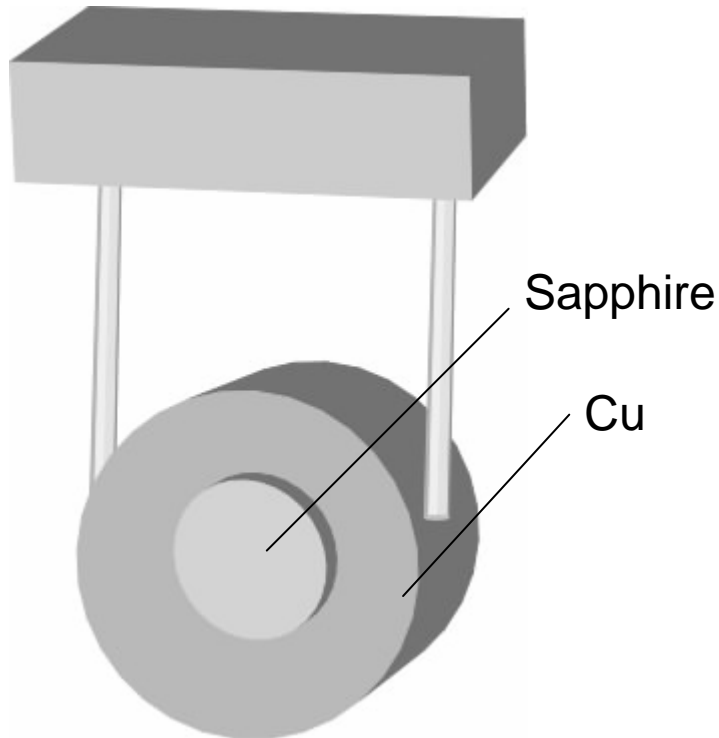


- Resonant frequency can be changed.
- Thermal noise can be reduced.



Composite mirror

Sapphire mirror + Cu external ring

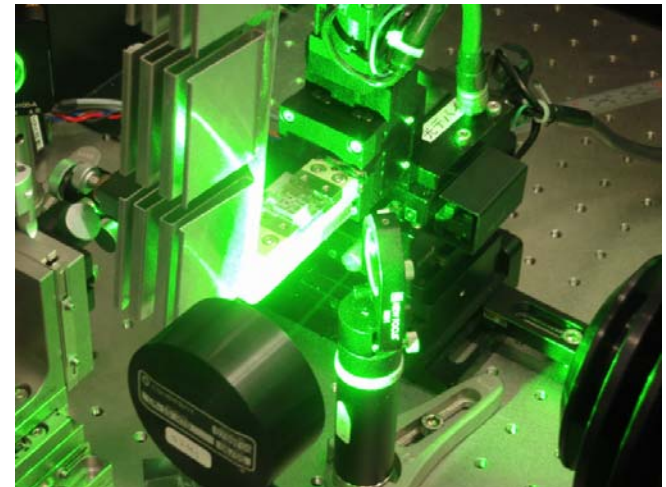


- FEM analysis showed almost no TN from the contact point [G040036-R]
- thermal expansion difference may be an issue



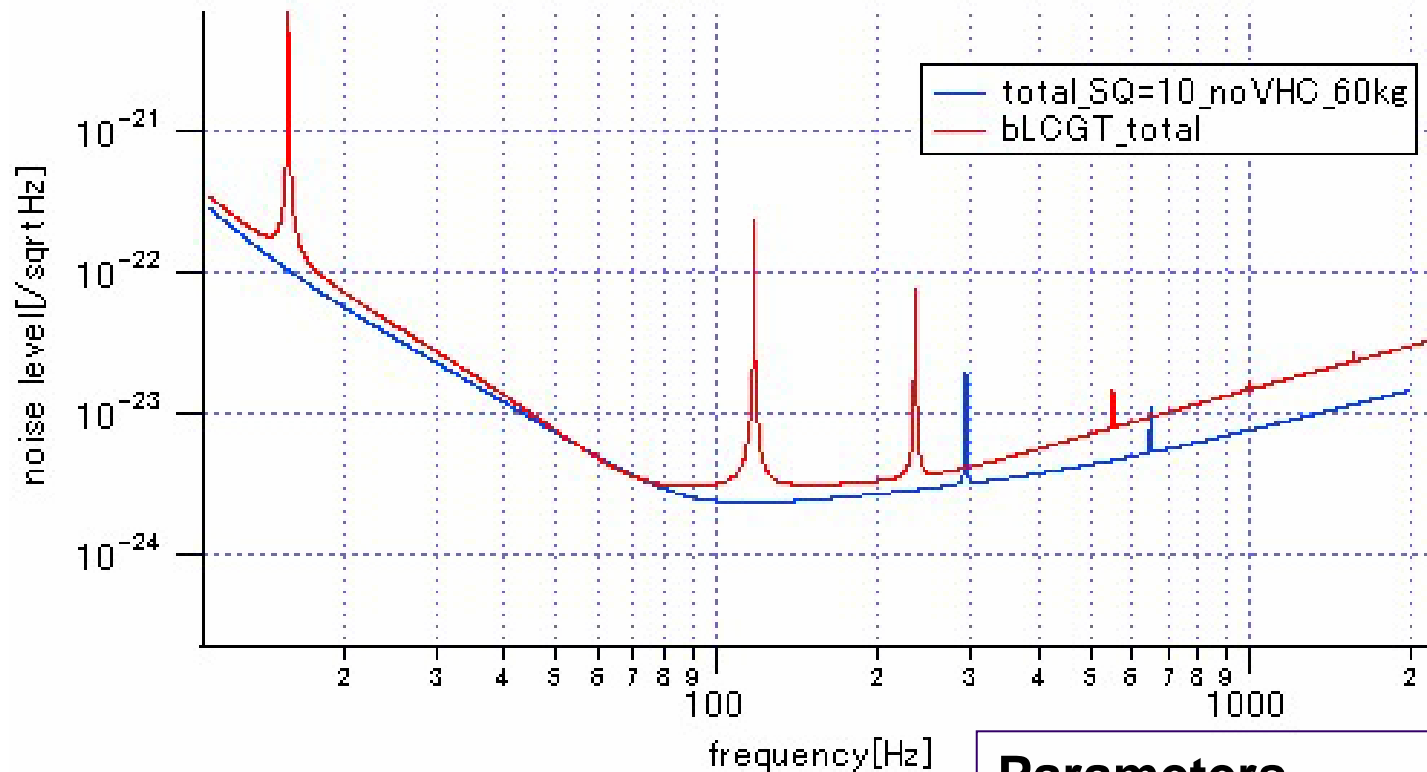
Apply squeezing for LCGT

- Lower arm power in LCGT
- Low power operation to avoid the heat problem
- Squeezing is attractive





All are included....



There could have a room to be improved bLCGT sensitivity!!

Parameters

VHC: 0

Squeezing factor: 10[dB]

Mass: 60 [kg]