LCGT Detector Configuration

Elba
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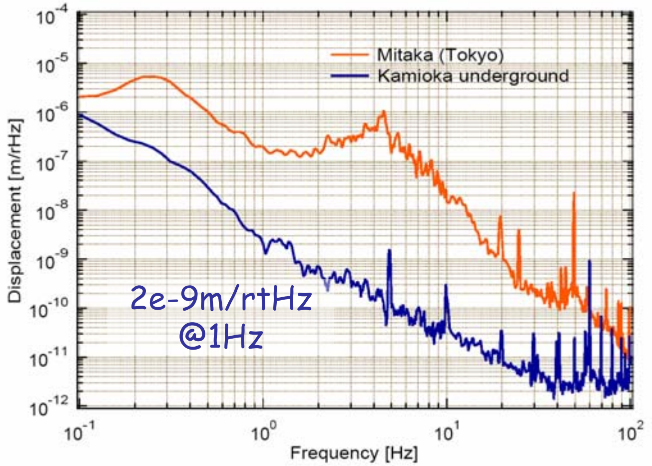
Tokyo Institute of Technology

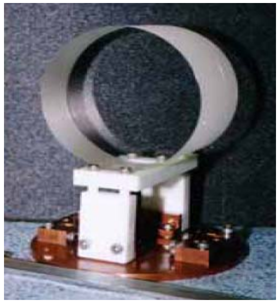
Kentaro Somiya

LCGT



Ground motion at Kamioka underground (blue)

SAS

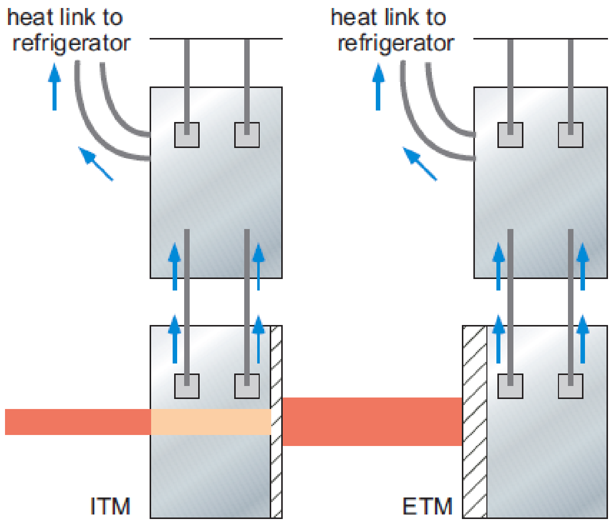


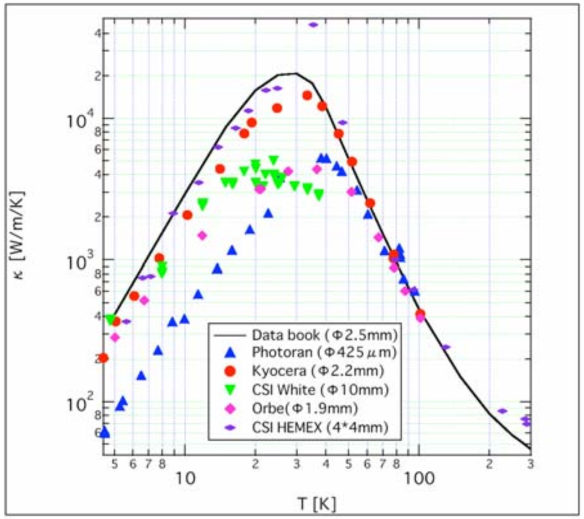
Sapphire mirror

Funded in 2010.6 ☺

- 3km IFO in underground
- 20K Sapphire test masses
- Sub-SQL sensitivity
- Several GW events per year

Cryogenic system





Thermal conductivity of Sapphire fiber

(1) Sapphire is good with 1064nm laser, and has high thermal conductivity

(2) 20K fiber can transfer ~1W heat

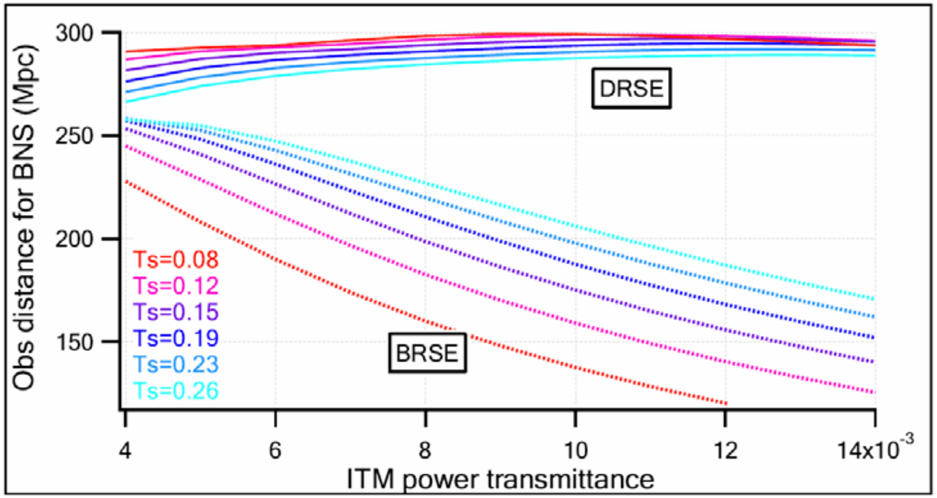
(3) Absorption of Sapphire substrate is not small

High-finesse RSE

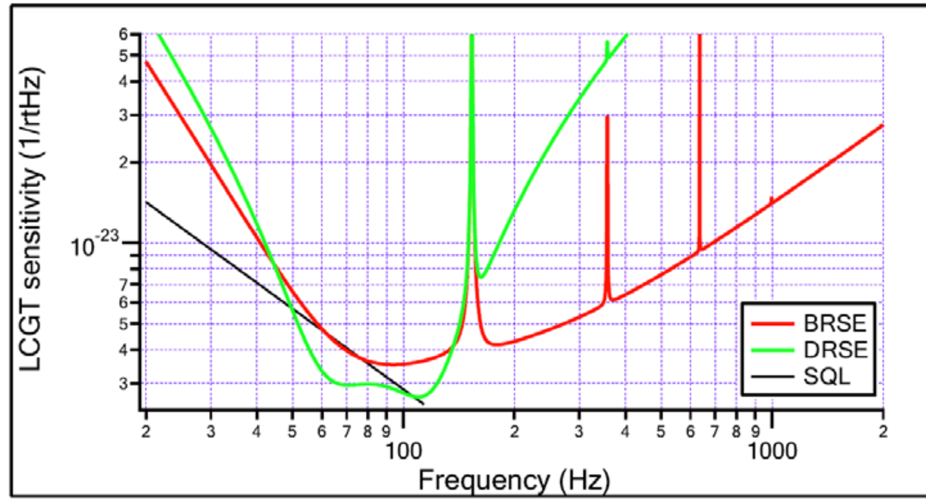
- decent power in PRC
- high power in the arm
- less absorption in ITM substrate

(Pprc=825W, F=1550, Wsub=0.24W, Wcoa=0.20W)

BRSE or DRSE



* GW from the optimal direction



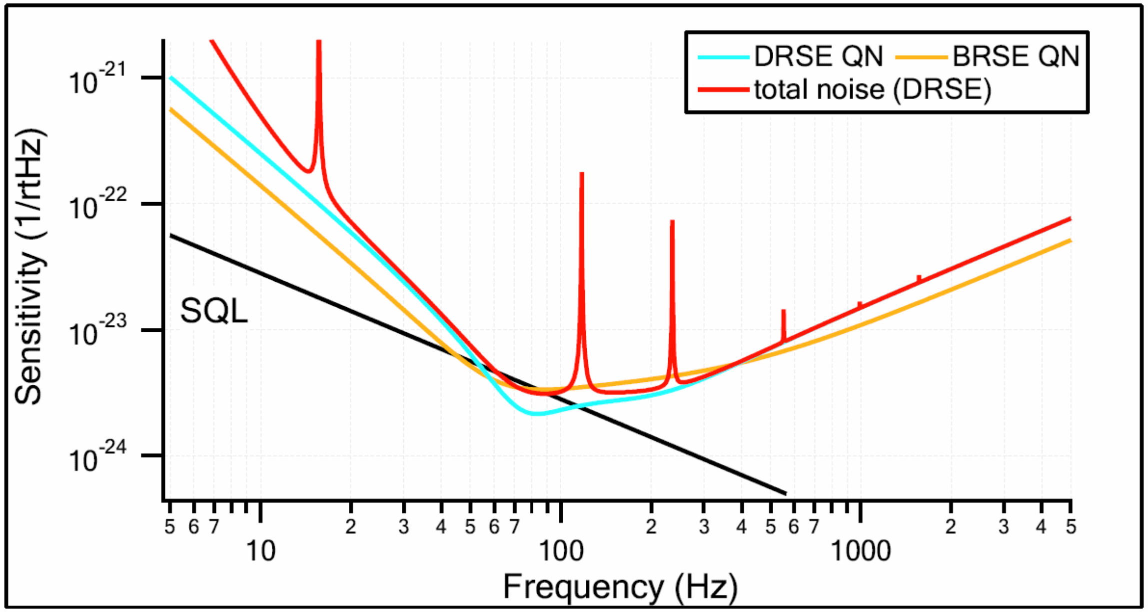
* These curves are old ones.

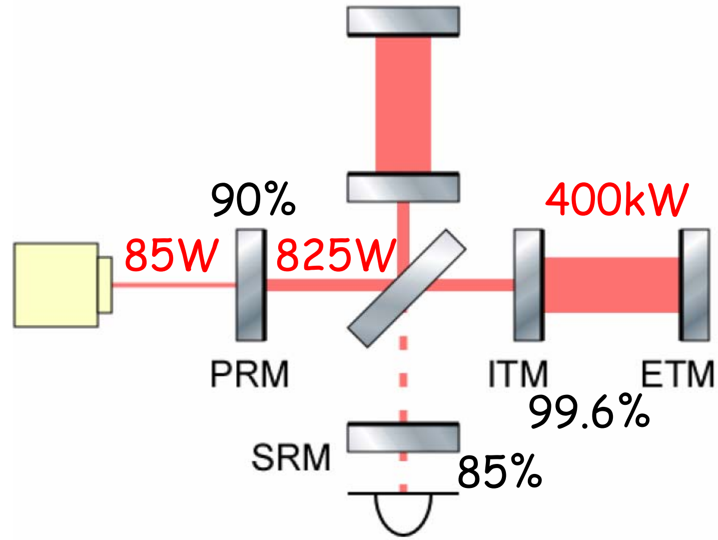
- Detuned RSE = narrow band, high inspiral range (~300Mpc)
  low-fineese x high SR is the best

- Broadband RSE = broad band, low inspiral range (~250Mpc)
  high-finesse x low SR is the best

➡ We decided to choose an intermediate one
(273Mpc and quite broad)

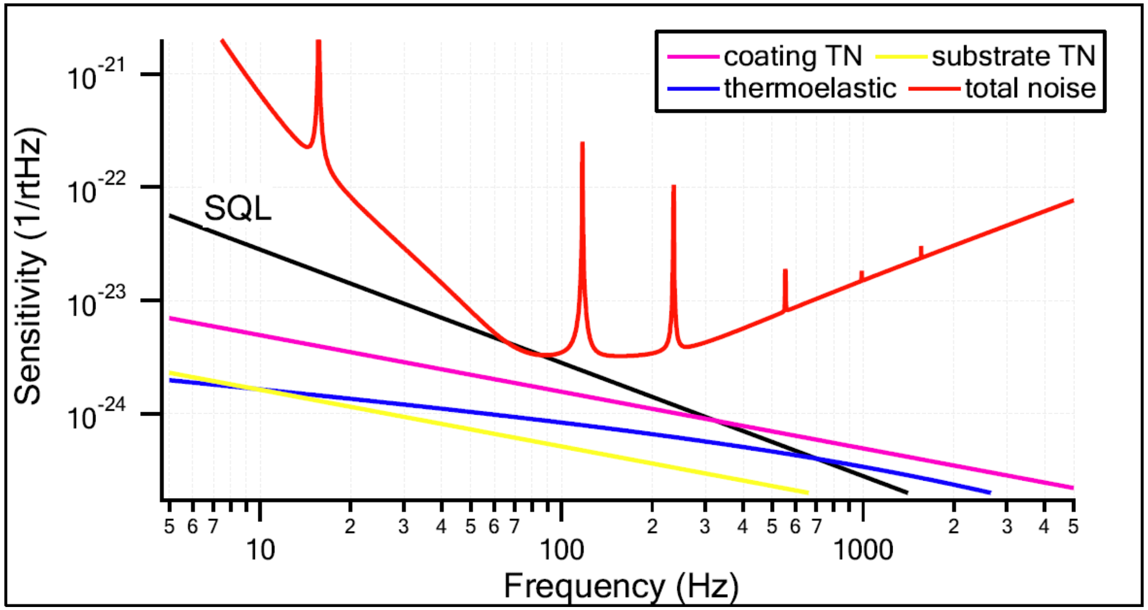
Quantum noise





- For DRSE, ϕ=86.5 deg, ζ=134.2 deg
- For BRSE, ζ=119.3 deg
- The best sensitivity is better with DRSE
- Bandwidth is broader with BRSE
- QN exceeds the SQL at around a certain frequency

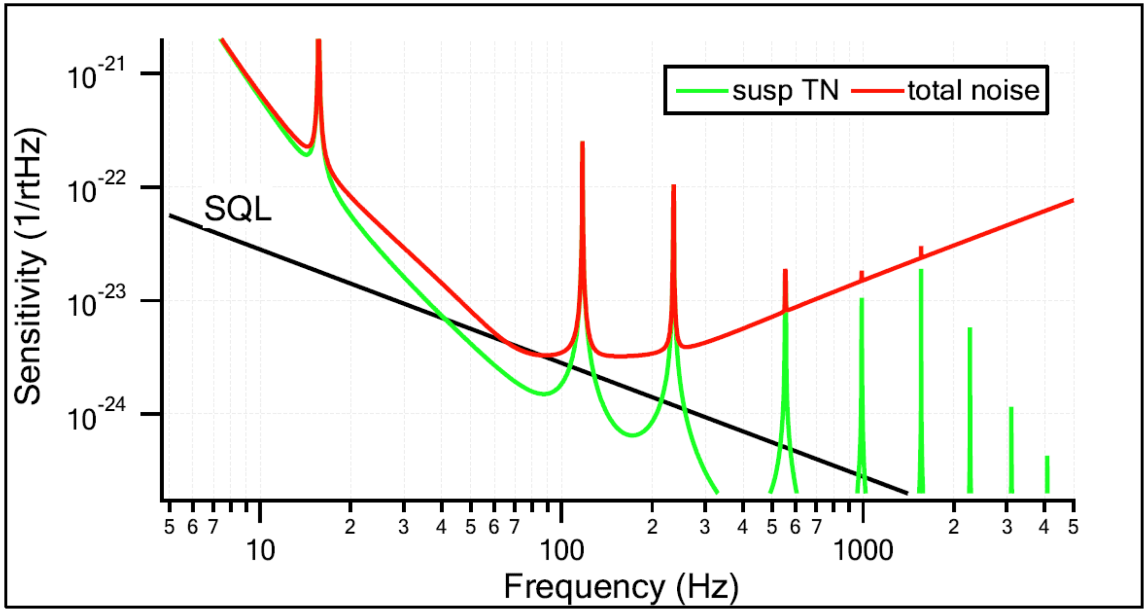
Mirror thermal noise



Mirror temperature 20K
Substrate Q=1e8
Tantala coating ϕ=5e-4
Silica coating ϕ=3e-4
ITM:9 layer, ETM:18 layer
Beam radii are 3.4/4.5cm
(flat-concave)

- Averaged coating loss requirement = 3.9e-4
- Measured value in Glasgow = 6.7e-4 (8e-4/5e-4)
- Measured value in U of Tokyo = 5.0e-4
- A new coating experiment at NAO

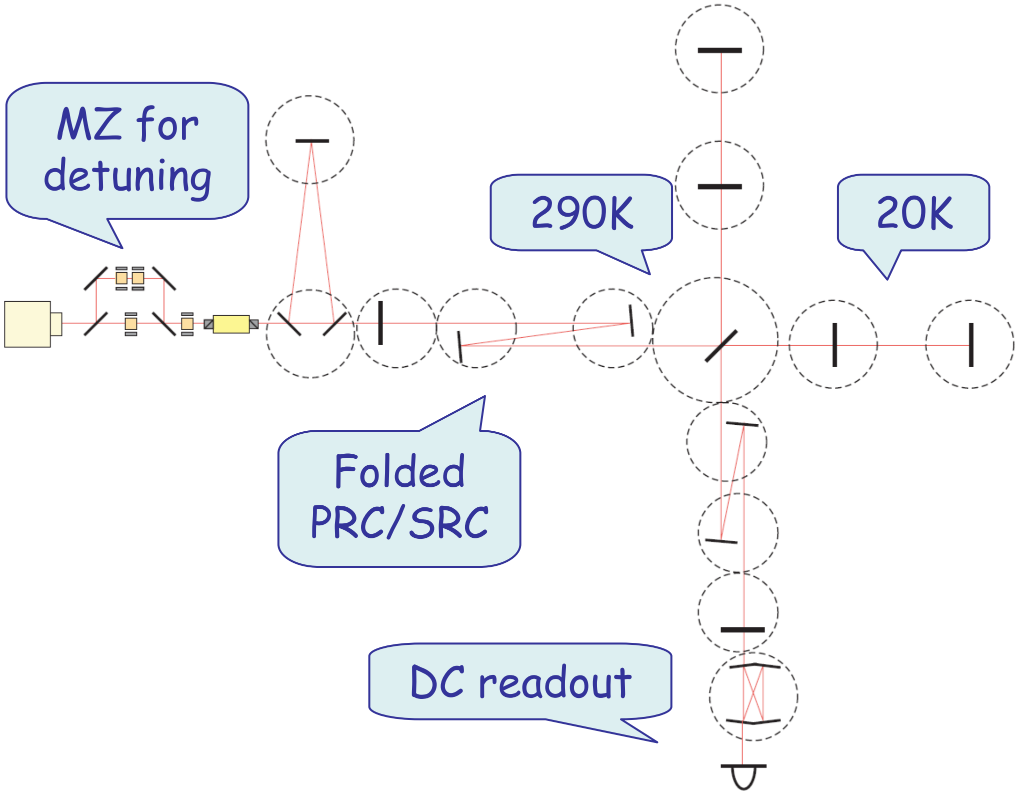
Suspension thermal noise

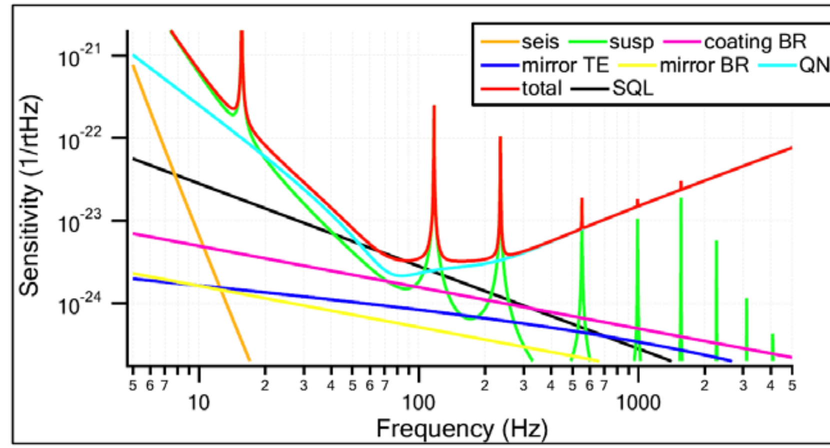


Values are for TM/IM/RM fiber
(test mass/intermediate mass/recoil mass)
Material=Sapphire/Tungsten/BeCu
Structure loss=5e-8/1e-4/5e-6
Fiber length=30cm/50cm/30cm
Fiber d=1.6mm/0.6mm/0.4mm
Clamp loss=0/1e-3/0
Ave Temperature=16K/10K/16K
Mini GAS freq=0.4Hz
HV coupling=1/200
IM/RM mass=60kg/30kg

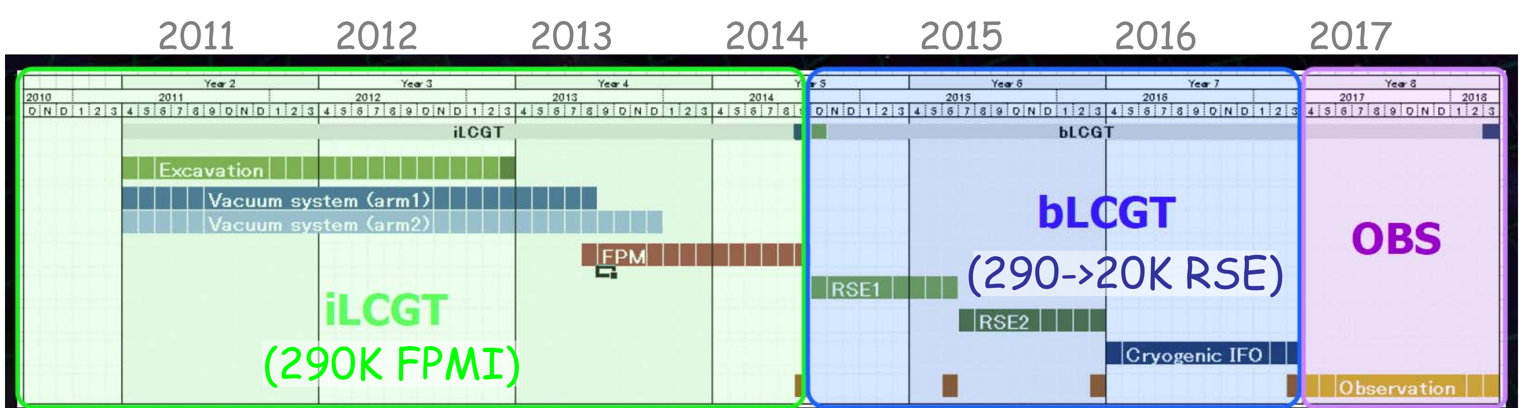
- The peak at 117Hz: vertical resonance
- The peak at 235Hz: first violin
- HV coupling is bad due to the tilted floor (1/300) for water drainage

Optical setup and schedule

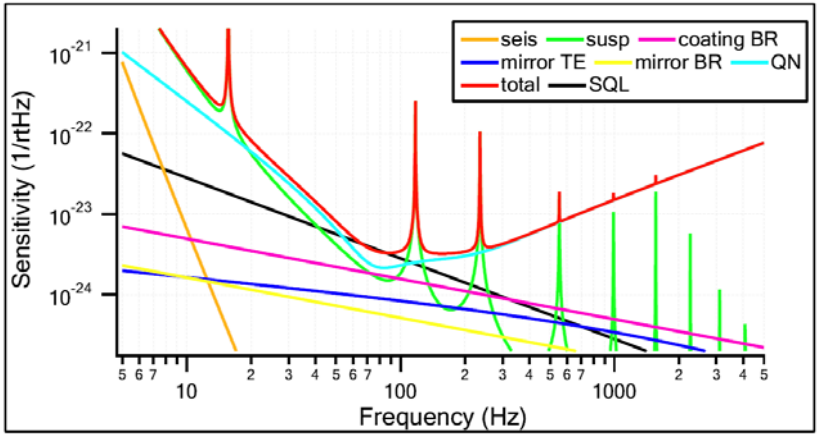




- BNS IR is 273Mpc
- BRSE Compatible (245Mpc)
- Cryogenic operation 2016~

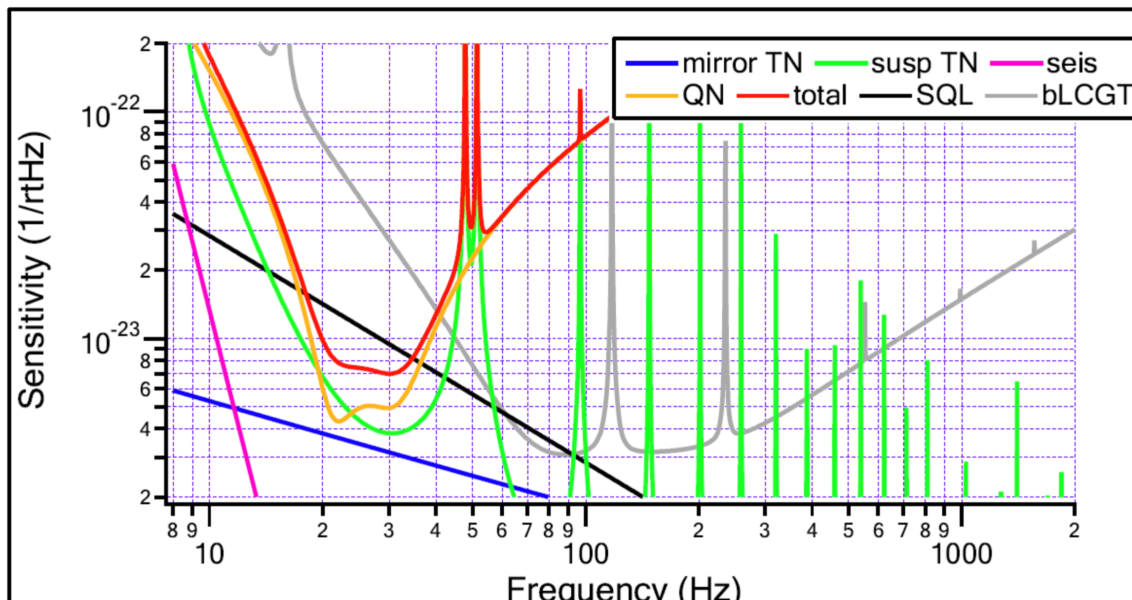


LCGT-LF discussion



- Seismic noise in underground is low
- Low-power operation may shift the curve to a lower frequency band
- Xylophone with aLIGO/AdVirgo

- Input power 1.5W
- PRG=11, Rsr=88%
- Finesse 1050
- Fiber length 120cm
- Fiber thickness 1.4mm
- Safety factor in cooling



Summary

- LCGT is now under construction
- 290K obs (2014), 20K obs (2017~)
- Low seismic noise [SAS design -> DeSalvo's talk]
- Cryogenic operation

  [Mirror Cryostat design -> Kimura & Sakakibara's talk]
- Sub-SQL
- LCGT-LF discussions

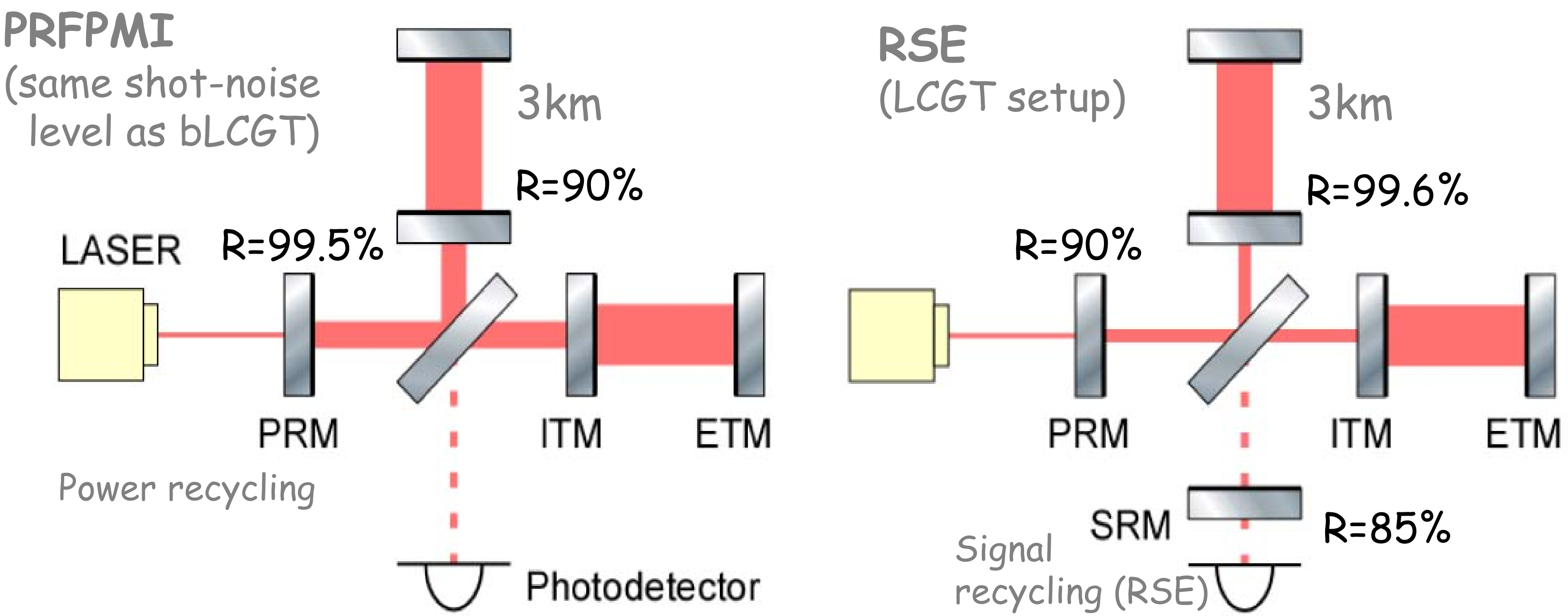
- Risk management
- Possible future extension

} Nishida's talk

Supplementary slides

RSE

RSE=Resonant Sideband Extraction



Laser power transmitting ITM would be 25 times higher w/o RSE

RSE is good for LCGT

825W in PRC, Arm power=400kW
Absorption in ITM substrate=0.24W
Absorption in coatings=0.20W