

Summary of Sensitivity Estimate for O4 in Various Interferometer Configurations

Yuta Michimura

Kentaro Somiya

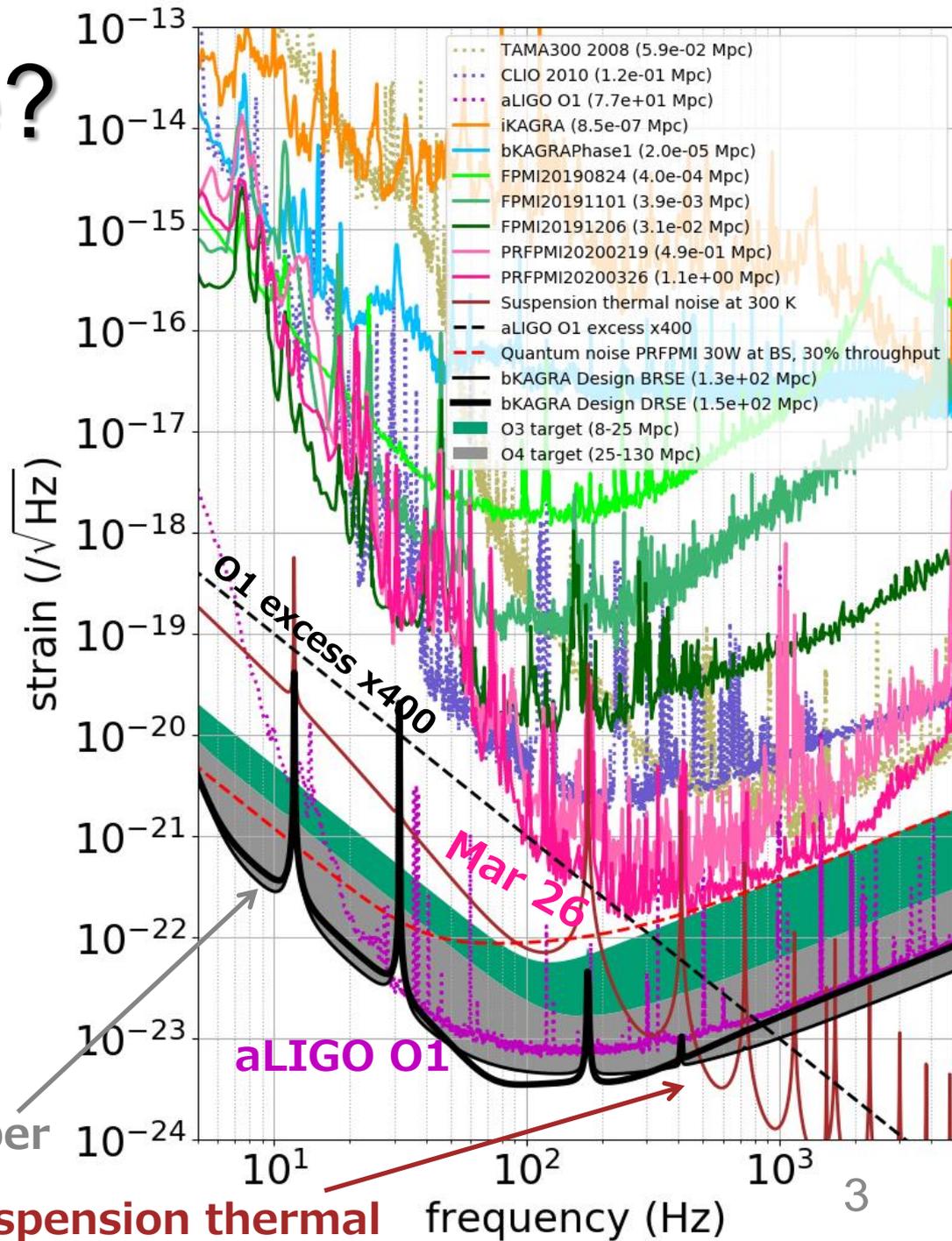
Kazuhiro Yamamoto

Assumptions

- IFO configuration: PRFPMI with 0% SRM or DRFPMI with 70% SRM, upto 300 W at BS (no shot noise coupling considered)
- Temperature: 22 K to 300 K (heat extraction capability not considered); see [JGW-P2011614](#)
- Frequency and intensity noise: current level or estimated noise in [JGW-T1910352](#)
 - Assume ITMs are not replaced (see [JGW-G2011541](#))
- Actuator noise: Not significant for O4 if we do it right (see [JGW-T2011661](#))

Where Are We?

- ~1 Mpc at best
- PRFPMI with 70% SRM tilted, 3-5 W to PRM, ~250 K, DC readout
- O1 excess x400
- Almost shot noise limited at high freq. (klog [#13560](#))



O4 target on Obs. Scenario Paper
25-130 Mpc by ~2021

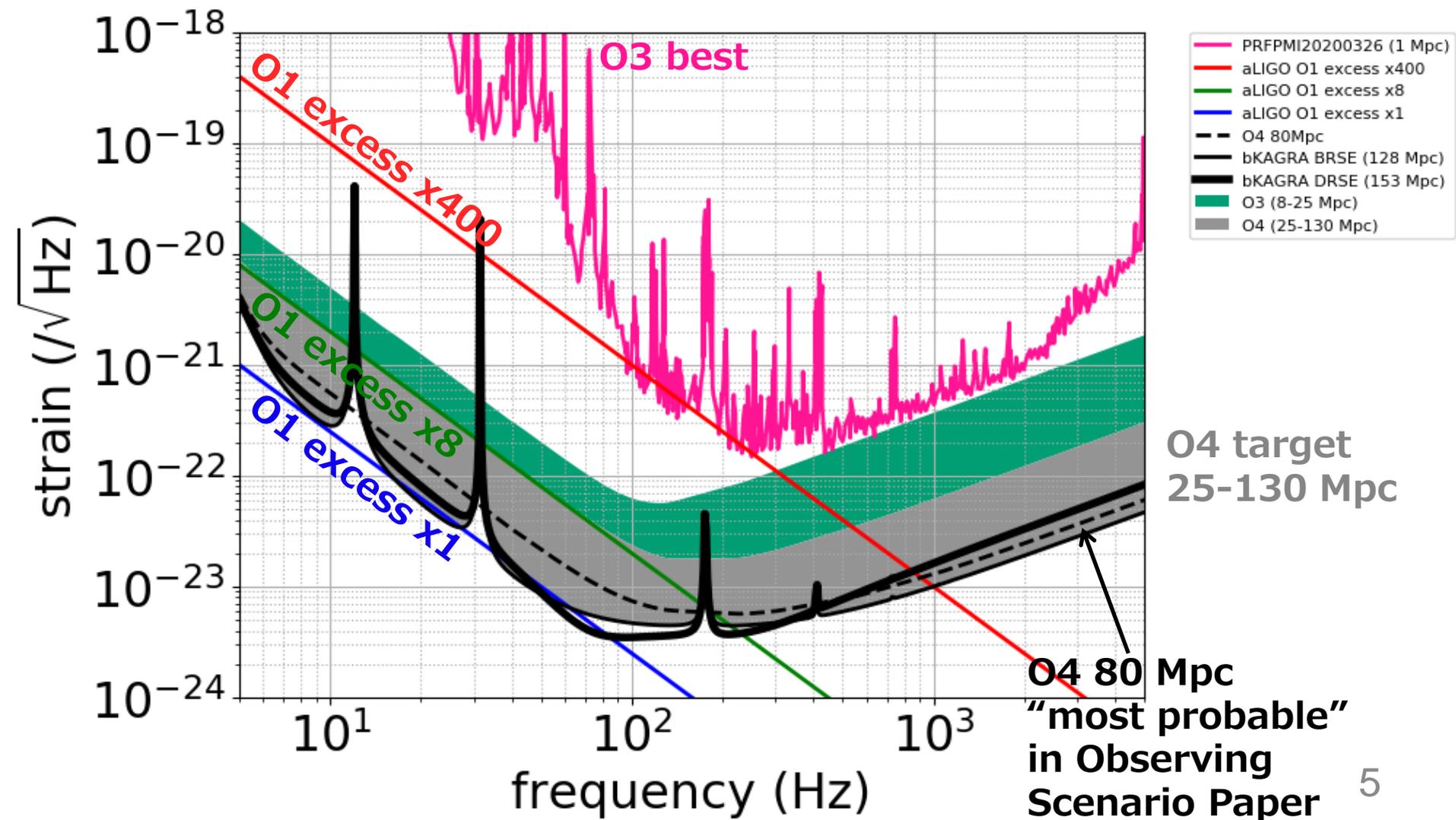
O3 best and O4 Target

	Mirror temp.	Power at BS	SRM reflectivity	Detuning angle	Homodyne angle	Excess noise
O3 best	~250 K	30-50 W	70% tilted	~90 deg (PRFPMI)	~90 deg (conventional)	O1 x 400
O3 low	22 K	10 W	0 %	90 deg (PRFPMI)	90 deg (conventional)	O1 x 20
O3-15Mpc	22 K	10 W	70 %	90 deg	90 deg	O1 x12
O3 high / O4 low	22 K	33 W	70 %	90 deg (BRSE)	90 deg (conventional)	O1 x 8
O4 80Mpc	22 K	404 W	85 %	90 deg	90 deg	O1 x 2
O4 high	22 K	673 W	85 %	90 deg (BRSE)	90 deg (conventional)	no excess
Design	22 K	673 W	85 %	86.5 deg	135.1 deg	no excess

For details, see [JGW-T1809078](#)

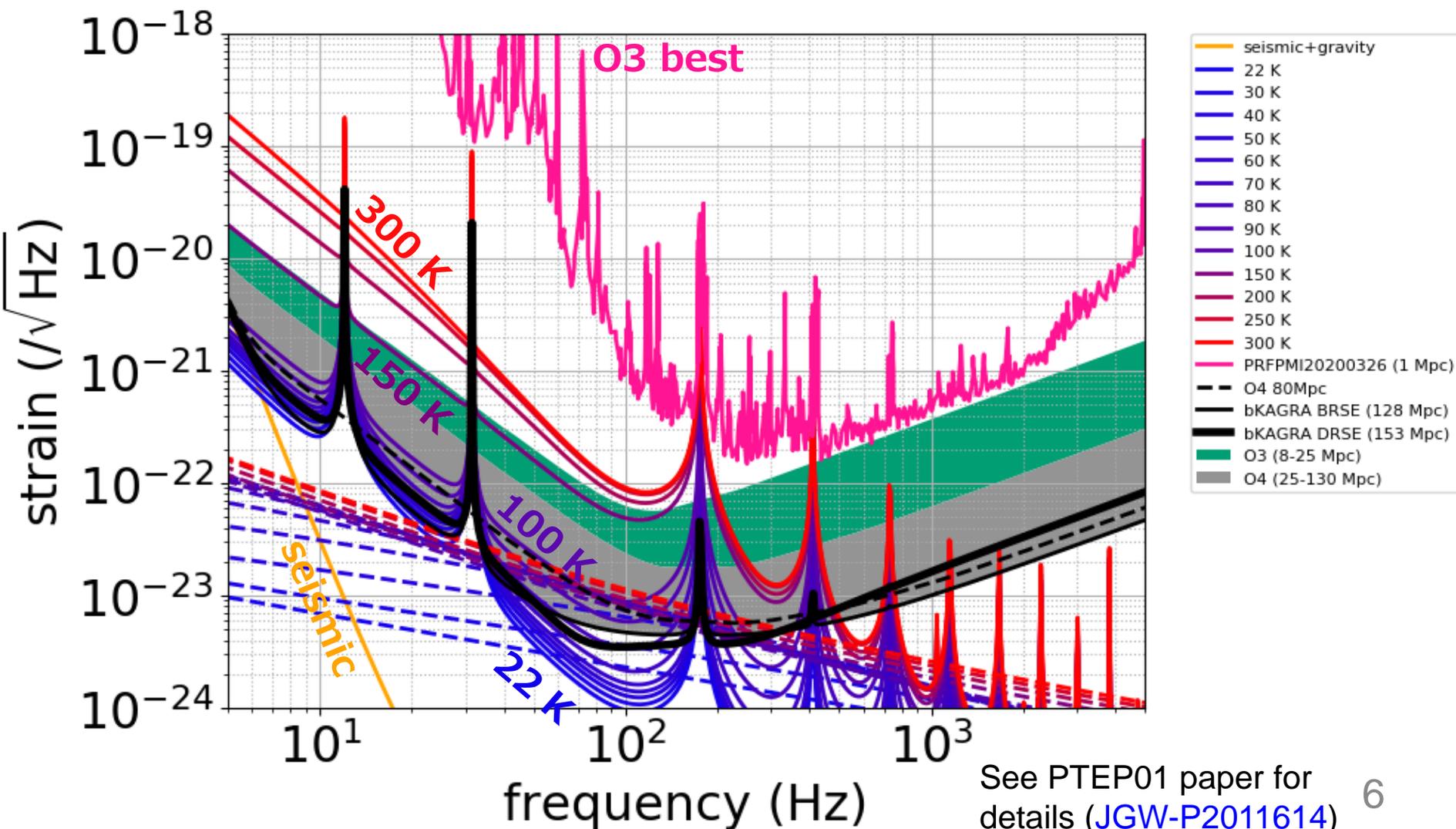
O3 best and O4 Target

- Excess noise should be reduced by at least $\sim 1/20$



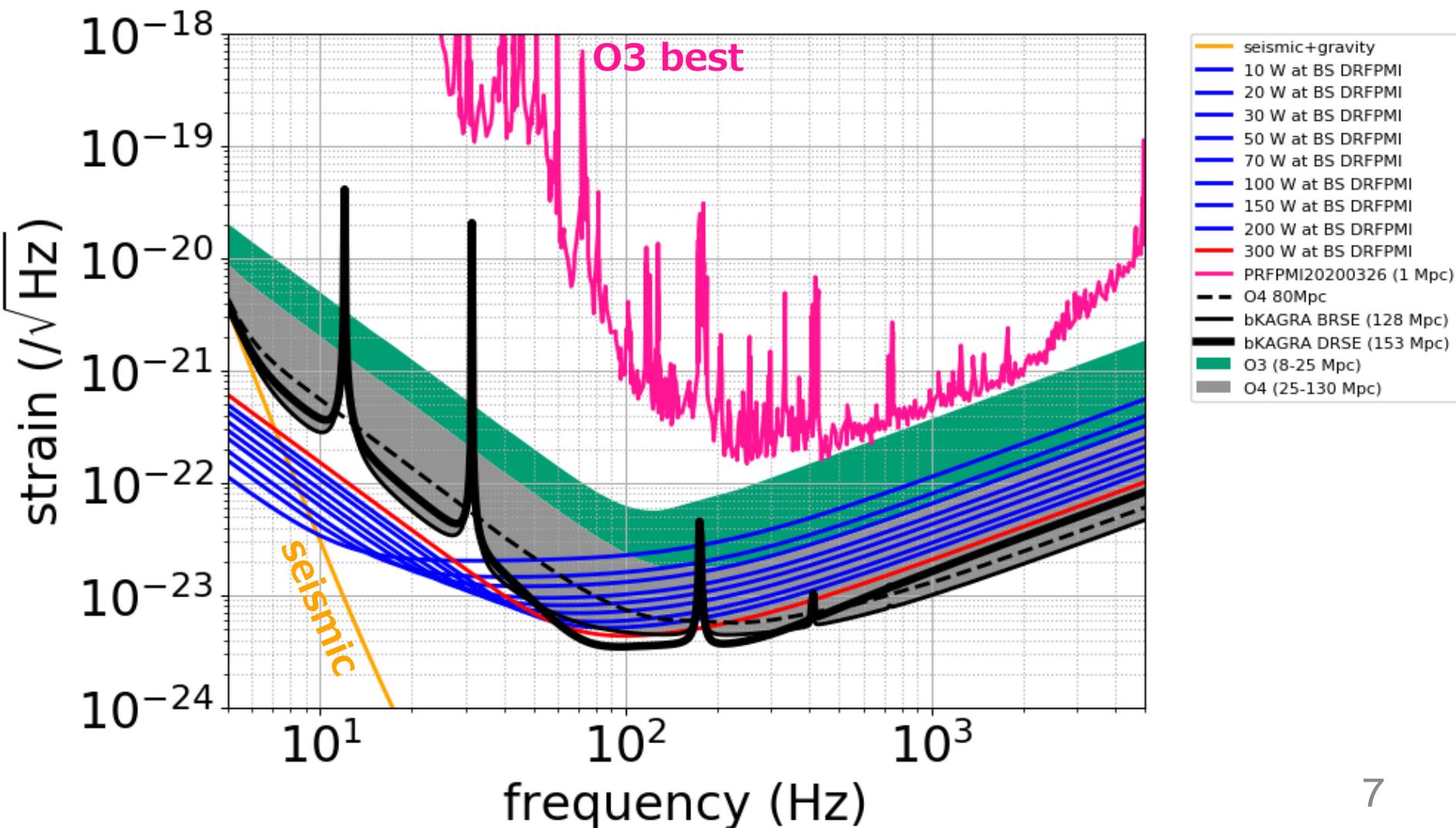
Various Thermal Noise

- 150 K is not enough but 100 K could be OK



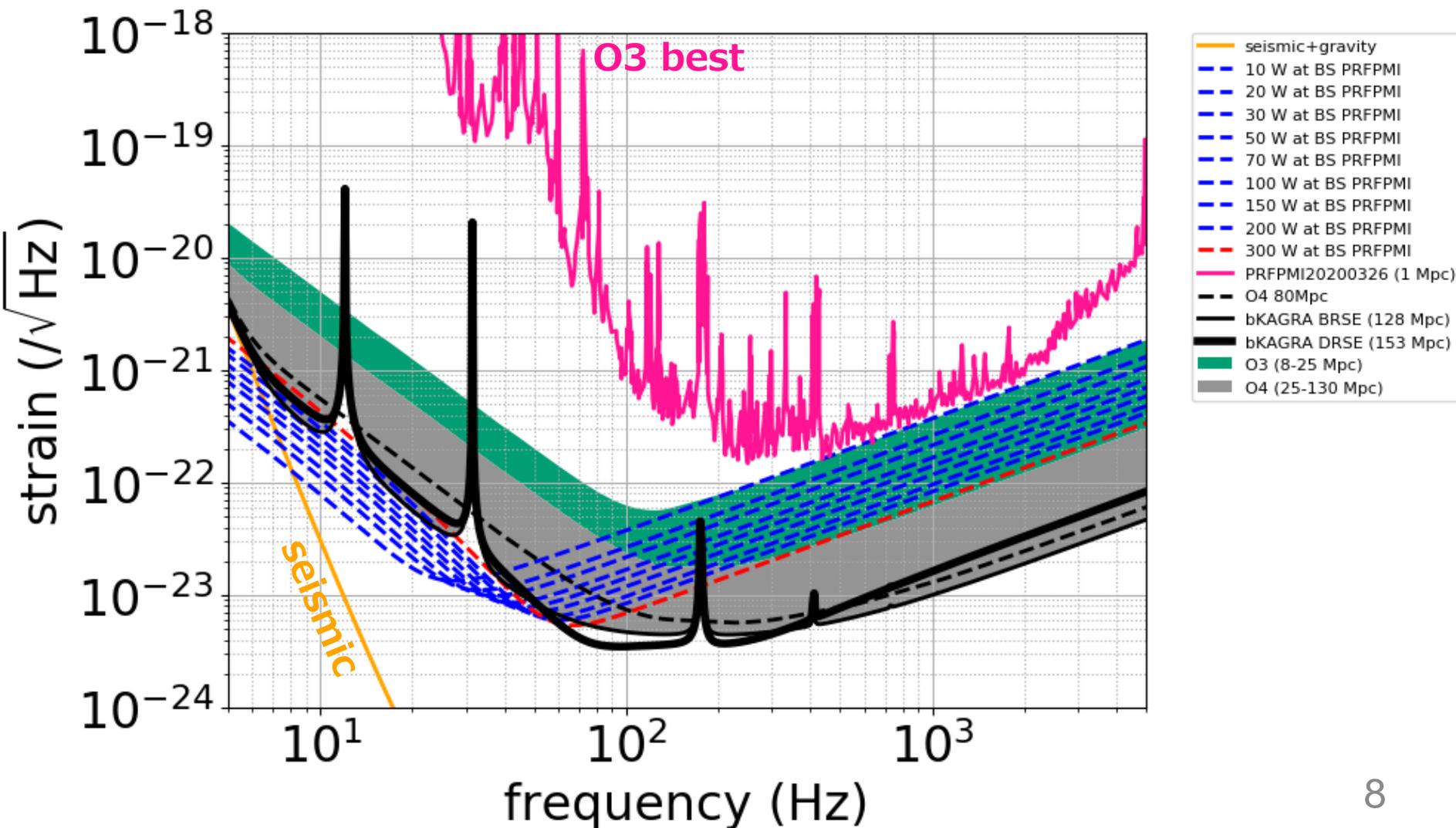
Various Quantum Noise (DR)

- 30 W at BS would be OK



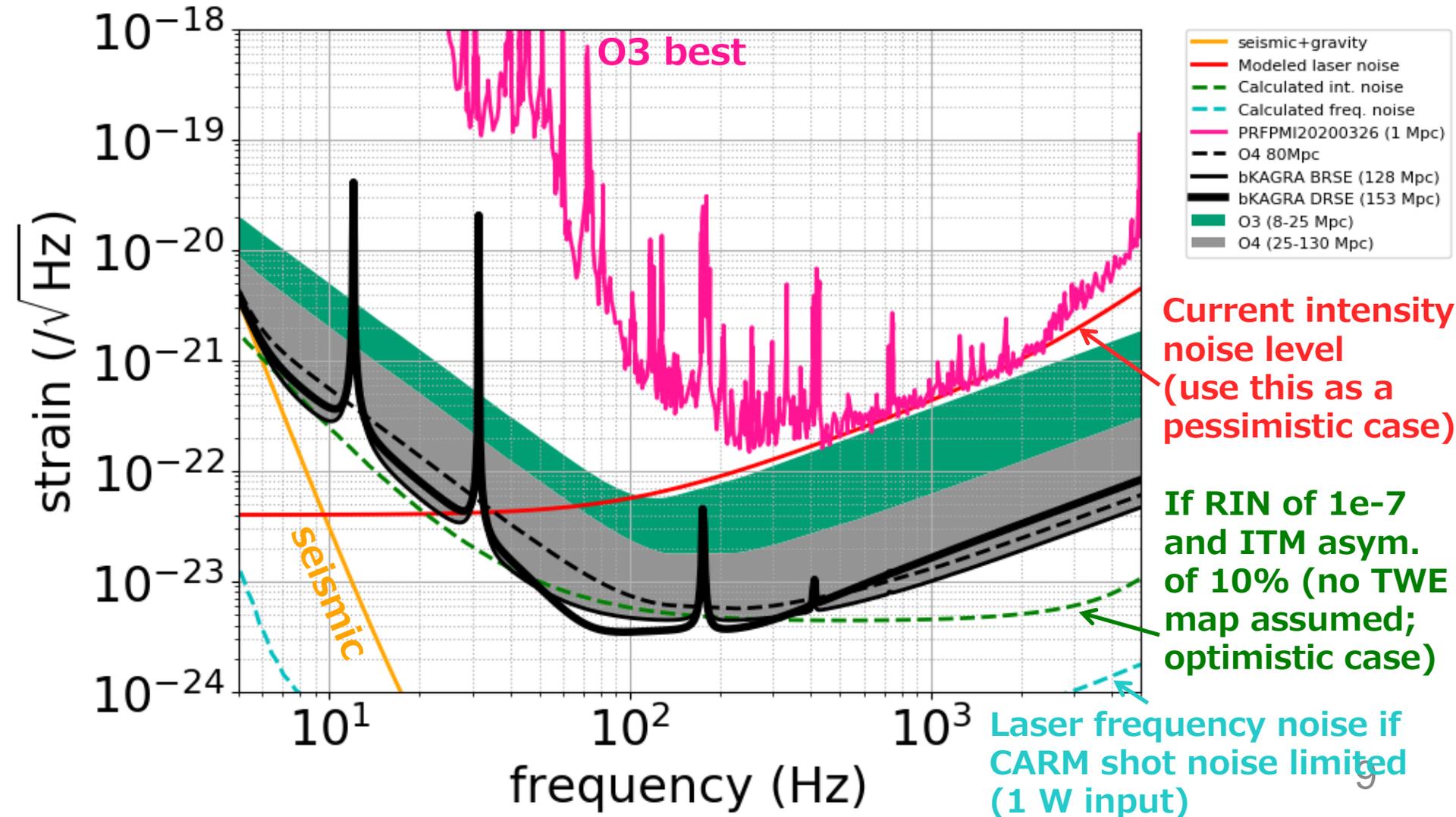
Various Quantum Noise (PR)

- High frequency sensitivity is not good



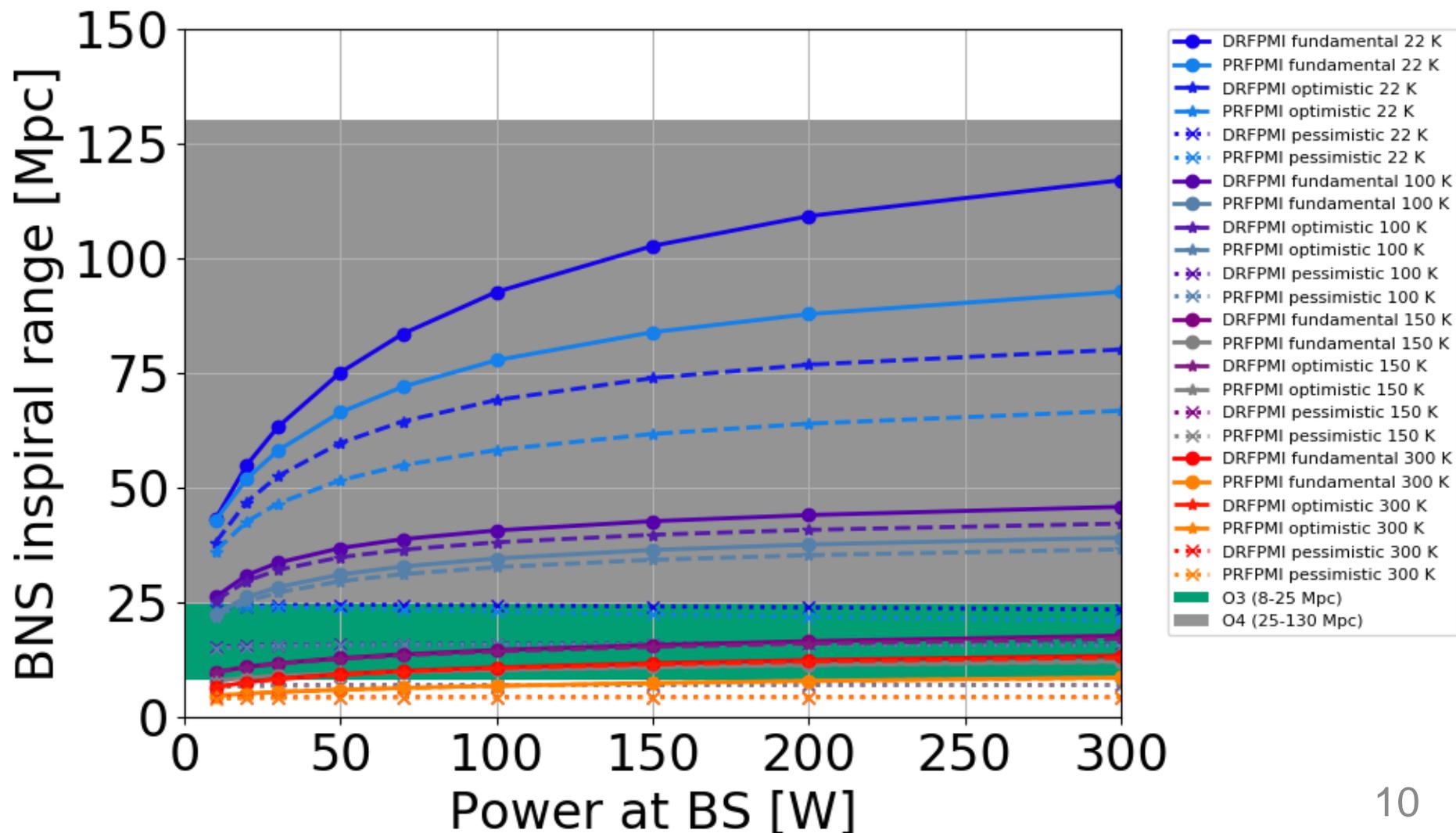
Laser Noises

- Hard to predict without measurements



Inspiral Range vs Power

- Power change not so significant with other noises



Conclusions So Far

- Low frequency noise should be reduced by at least a factor of ~ 20
- Should be below ~ 100 K
- Higher power is better, but not so important especially when other noises are high
 - 30 W at BS could be enough
- As we have been keep saying, investigations on current noises are very important (low frequency noise; laser intensity and frequency noise) for estimating the sensitivity in O4