Erratum: Frequency noise and intensity noise of next-generation gravitational-wave detectors with RF/DC readout schemes [Phys. Rev. D 73, 122005 (2006)]

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I. MODIFICATION OF ERRORS IN CALCULATION CODES

In *original* Fig. 10, laser noise spectra of detuned RSE with DC readout were flipped between top and bottom panels. Also we found some errors in the code used for the computation. Corrected results with the same parameters are shown in *new* Fig. 1. The correction of the code applies also to *original* Fig. 6, and the corrected results are shown in *new* Fig. 2. Here the readout phase for the detuned RSE is $\pi/2 - 0.04$.

II. MODIFICATION OF PARAMETERS

It is not an error but we have also found that some parameters are not realistic. Let us make a correction here. A mismatch in optical losses per round-trip between two arm cavities, denoted as $\Delta\epsilon$, was assumed to be 5 ppm in the paper, but this number has turned out to be too optimistic. In the Advanced LIGO project, for example, 30 ppm loss imbalance is assumed. We shall use this number. Furthermore, as we mentioned in the paper, intensity stabilization with 1 W light will be too challenging. Let us change it to 100 mW to be more realistic. *Original* Figs. 3, 6, 8, and 10 will be changed as follows (*new* Figs. 3–6, respectively). In *new* Fig. 6, we have changed the readout phase for the top-right panel from $\pi/2 - 0.04$ to $\pi/2$.

According to the changes, the first part of the second paragraphs in Sec. III D 2 should be rewritten as follows:

"In the case of detuned RSE with DC readout, it is known that the sensitivity with the readout phase ($\neq \zeta$) being $\pi/2$ is better at low frequencies but worse at the frequency of the best sensitivity than that with the readout phase being 0 [10] [11]. The radiation pressure offset can be completely removed, with a sufficient control gain, by choosing $\zeta = \phi(\sim\pi/2)$, in which case the arm length mismatch only contains the drift, after suppression from the optical spring: $\Delta L_{\mathrm{D}} = \Delta L_{\mathrm{rms}} \sim 10^{-13}$ m. If we choose ζ to be far from ϕ, for example $\zeta = 0$, then the actual mismatch ΔL_{D} is larger, because an artificial imbalance needs to be introduced to create a local oscillator."

Also the second and the third paragraphs in Sec. III F should be rewritten as follows:

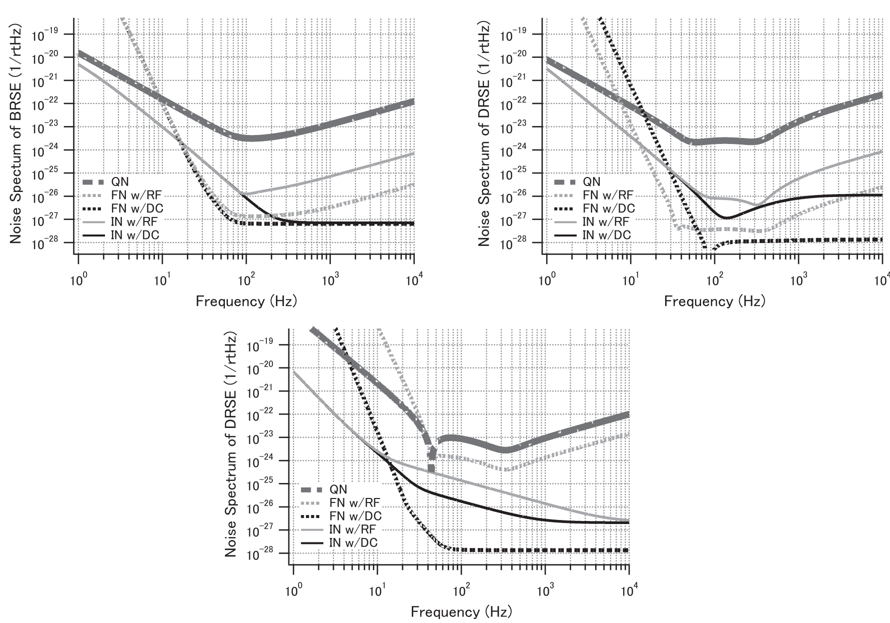

FIG. 1. *(Original Fig. 10)* Quantum noise and laser noise of the broadband RSE (left), the detuned RSE with ζ or $\zeta_{\mathrm{DC}} = \pi/2 - 0.04$ (top-right), and the detuned RSE with ζ or $\zeta_{\mathrm{DC}} = 0$ (bottom-right).

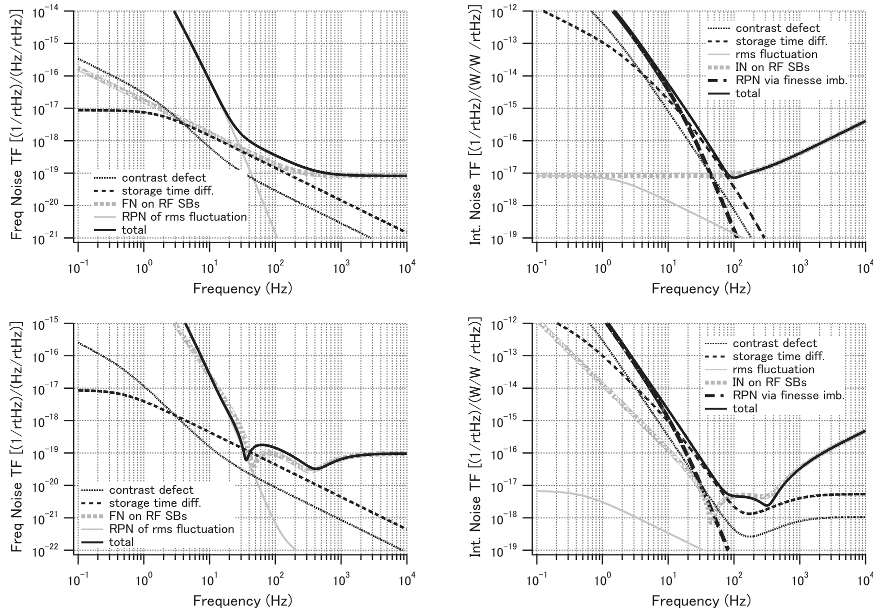

FIG. 2. *(Original Fig. 6)* Laser noise of the broadband RSE (top) and the detuned RSE (bottom).

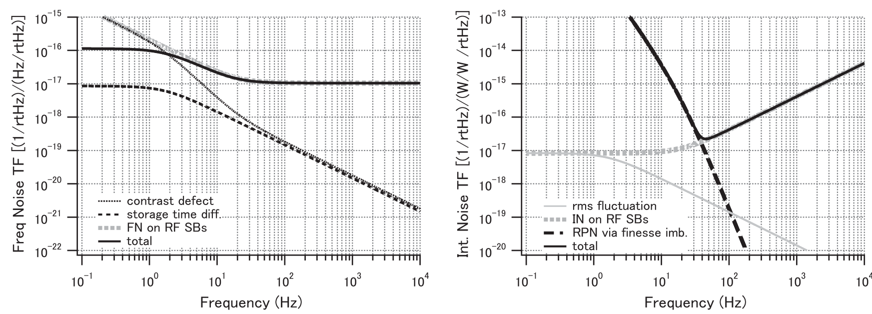

FIG. 3. *(Original Fig. 3)* Frequency noise (left) and intensity noise (right) of the power-recycled Fabry-Perot Michelson interferometer, calculated. Here the transfer function from each fluctuation to the equivalent strain sensitivity are shown.

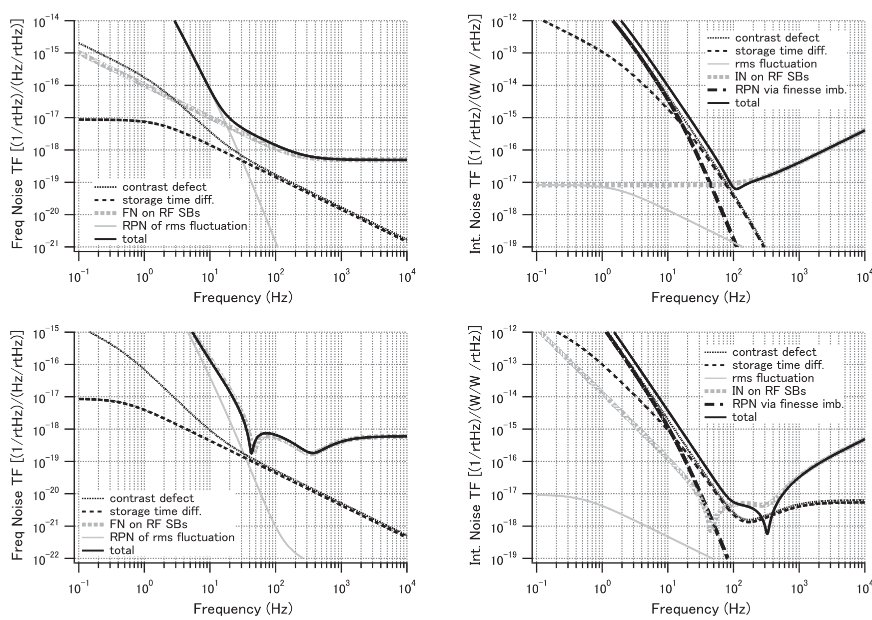

FIG. 4. *(Original Fig. 6)* Laser noise of the broadband RSE (top) and the detuned RSE (bottom).

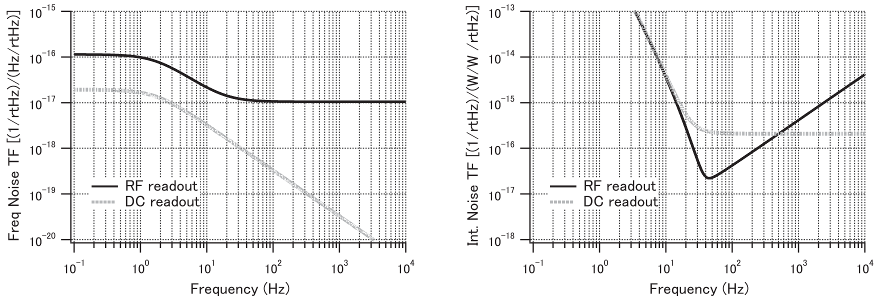

FIG. 5. *(Original Fig. 8)* Laser noise with the DC and the RF readout scheme.

"In the case of the broadband RSE, laser noise is mostly smaller than the quantum noise level. Frequency noise is larger than quantum noise at frequencies below $10 \sim 20$ Hz, but seismic noise, which is not described here, will anyway limit the sensitivity at the frequencies.

In the case of the detuned RSE, laser noise can limit the sensitivity if ζ is close to zero. This is due to the fact that the particular readout phase that gives the leaked carrier light at the dark port infinity is close to zero; see Eq. (58). Since the readout phases of RF readout (ζ) and DC readout ($\zeta_{\rm DC}$) are different by $\pi/2$, laser noise with either scheme exceeds the level of quantum-noise-limited sensitivity and the other one does not in the observation band. Changing the readout phase between 0 and $\pi/2$, we see laser noise start invading the sensitivity at around the optical-spring frequency when the readout phase becomes higher than $\sim\pi/2 - 0.004$ with DC readout, and lower than ~ 0.2 with RF readout. The optical-spring dip is steep and the highest narrow-band sensitivity could be achieved at the frequency when the readout phase is close to zero. On the other hand, the sensitivity at low frequencies is better with the readout phase close to $\pi/2$. The readout phase should be chosen carefully with a consideration of laser noise due to our calculation and target gravitational-wave sources."

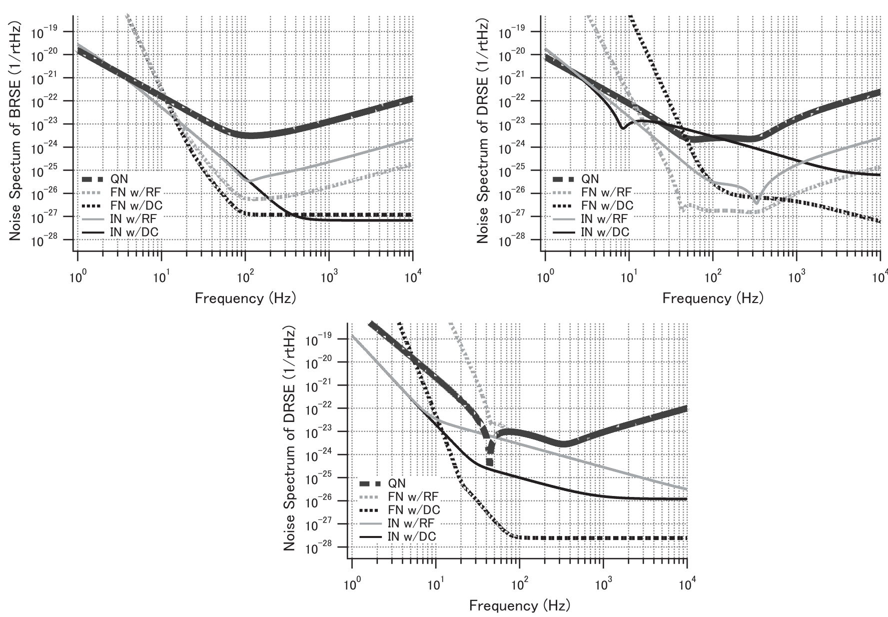

FIG. 6. *(Original Fig. 10)* Quantum noise and laser noise of the broadband RSE (left), the detuned RSE with ζ or $\zeta_{\rm DC} = \pi/2$ (top-right), and the detuned RSE with ζ or $\zeta_{\rm DC} = 0$ (bottom-right).