IMC length noise requirement

A first requirement on IMC length noise has been shown on VIR-0501A-10. This requirement considers the transfer function of IMC length noise to h, the advanced Virgo sensitivity and the loop gain of SSFS. However, residual motion of IMC should also not disturb resonance of carrier and sidebands. This requires the power at the end of IMC to not drop more than 0.1%. Therefore, it gives a residual motion on IMC of:

$$\partial z_{rms} < \frac{\lambda}{4F\sqrt{2}}\sqrt{\frac{1}{1000}} = 4{,}6.\,10^{-12}m$$

With F the IMC finesse. This note gives IMC length noise by considering also this residual motion requirement. Moreover, as presented in VIR-0510A-10, the finesse of arm cavity changes to 450. Requirement is thus calculated for this new finesse.

I.IMC length noise without rms specification

Figure 1 gives IMC length noise when the IMC residual motion is not taking into account. Cases of arm cavity finesse of 897 and 450 are computed and show comparable requirement. These requirements are easier for frequencies lower than 70Hz than ground motion.

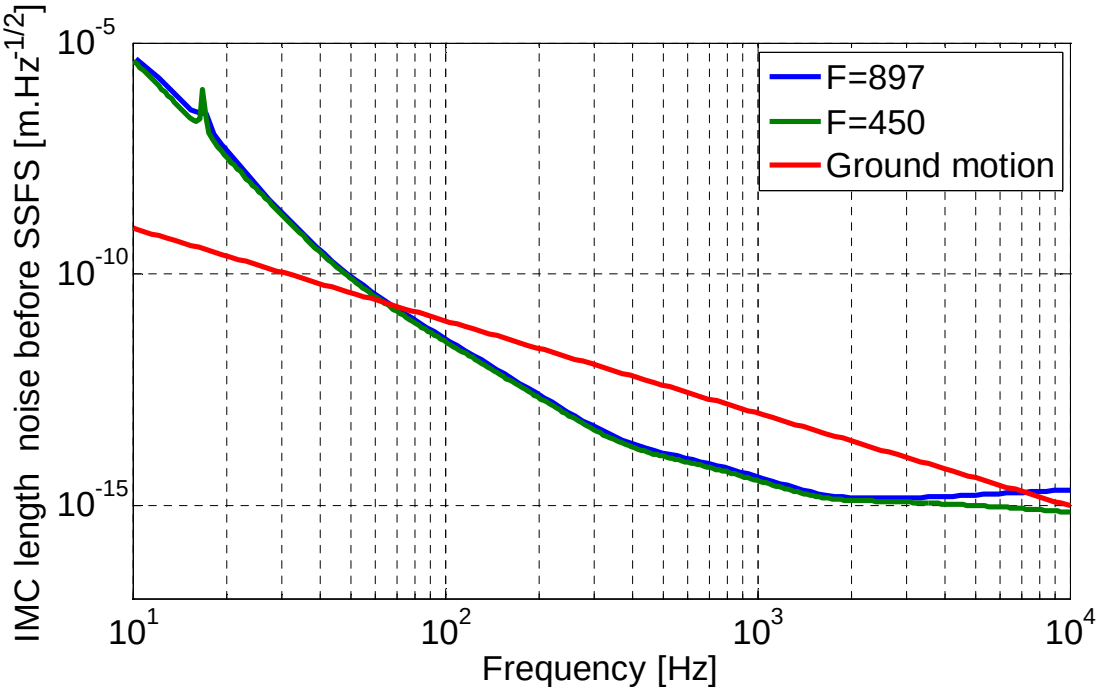

Figure 1: IMC length noise requirement before frequency loop stabilization.

II. rms specification

rms motion can be calculated from the power spectral density (PSD) by:

$$\partial z_{rms} = \sqrt{\int_{10Hz}^{10KHz} PSD.df}$$

In that case, Ground motion leads to an rms motion of $1{,}8.10^{-9}$m. Due to high noise at low frequencies, IMC length noise leads to an rms motion of $4{,}5.10^{-6}$m.

In order to obtain a correct requirement, IMC length noise has been reduced at low frequencies.
Figures 2 gives an IMC length noise requirement which shows the same noise floor given at section 1 and an rms motion of $4{,}6.10^{-12}m$.

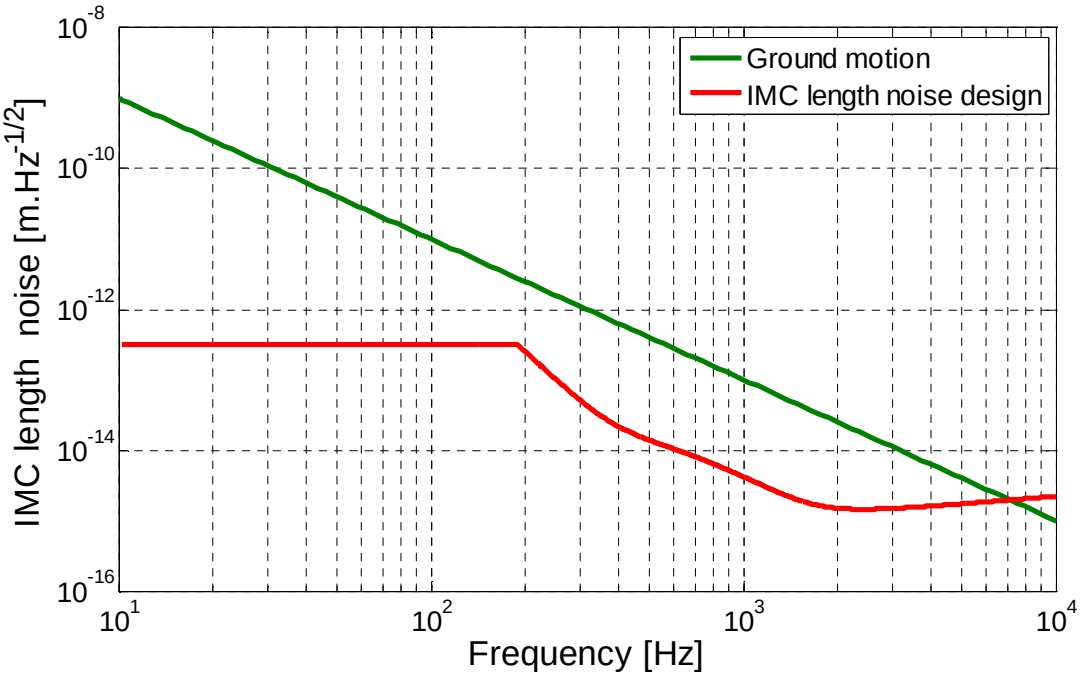

Figure 2: IMC length noise requirement for rms specification.