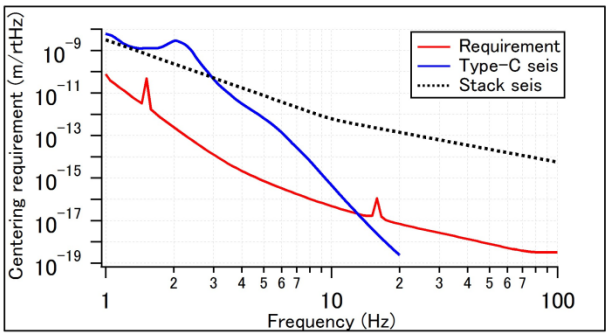
Analysis of miscalculations in the simulation for the OMC suspension requirement

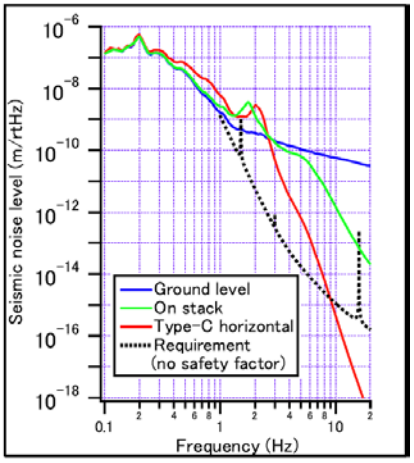
2016.6.1

K.Somiya

The requirement of the OMC beam miscentering was calculated in 2014 and in 2015 but the results have turned out to be wrong. This report explains how the requirement was miscalculated.



OMC miscentering requirement in 2013 [JGW-G1402105]



OMC miscentering requirement in 2015 [JGW-G1504102]

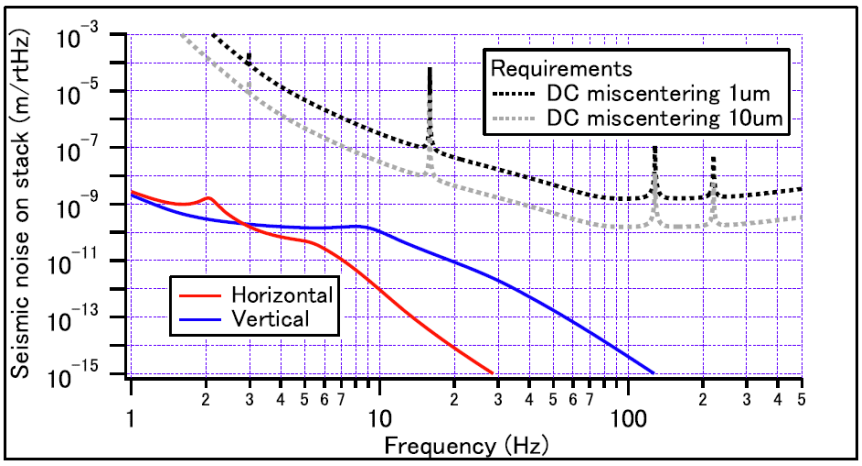
The requirement at 10Hz was 1e-16m/rtHz in 2013 and 1e-15m/rtHz in 2015 (see the results in the above figures). They are quite close but both were very wrong.

In 2013, the requirement was calculated with FINESSE; more concretely, using the fsig and xbeta commands that drive the steering mirrors before the OMC. The code was roughly correct but the plot used in the report was not for the miscentering but for the optical path length of the OMC. The actual requirement for the miscentering calculated in 2013 is **1e-10m/rtHz** at 10Hz with the 1um RMS miscentering.

In 2015, the requirement was again calculated with FINESSE in the same way as 2013. The calculation is explained in JGW-G1504102. The transfer function from DARM to AS output power was 440W/m and the transfer function from OMC miscentering to AS power was 0.2W/m, and then the requirement was given by the KAGRA sensitivity times 440/0.2. First, there was a typo in the report and it says the requirement is the sensitivity times 0.2/440. Second, it uses 0.77 instead of 0.2 for the plot. Third, the transfer function from DARM to AS turns out to be not in W/m but in W/rad, so that the

correct value is 440 times 2pi/1064nm. Thus, the requirement becomes 1e-15 x 0.77/0.2 x 2pi/1064nm, that is, **2.8e-8m/rtHz** at 10Hz. Here the RMS miscentering is 1um.

In 2016, we corrected the distance between the OMMT2 and the first steering mirror for the miscentering simulation (it was 2.75m and now it is corrected to 1.75m). In the beginning we suspected that the fsig function may not work well with the xbeta function so that we tried to derive the transfer function from the miscentering to AS power by calculating the error function slope. Finally it turned out that the result is just the same as the one given from the fsig and xbeta functions. Anyhow the transfer function from the miscentering to AS power was given as 0.043W/m and the transfer function from DARM to AS power was given as 6.8e9 W/m. Thus the requirement was given by 2e-18 x 6.8e9 / 0.043 = **3.0e-7 m/rtHz** at 10Hz with the RMS miscentering of 1um.



OMC miscentering requirement in 2016 [JGW-G1605256]