Revisiting the SR3 Tilt Sensing OpLev

This time I attempted to obtain the constant pitch and yaw line by using actuation from the intemdiate mass. For the first trial, I simply applied IM yaw and IM pitch separately and marked down the output from the QPD. However, while IM yaw only moves the IM in the pure yaw direction, I noticed that when I apply IM pitch, the IM will also move in the yaw direction. So, for the second attempt, when I actuated the IM in the pitch direction, I also actuate the IM in the yaw direction so to keep the IM moving with constant yaw. Results obtained from the QPD showed that the TM yaw aligned with the QPD horizontal while TM pitch doesn't align with the vertical axis, i.e. TM yaw and TM pitch appeared to be not diagonal to each other, which still doesn't make any sense. Later I discovered that the IM pitch actuation doesn't only couple with yaw but also with roll. Moreover, the IM yaw actuation also makes the IM to move in roll direction. If the TM weren't wedged, this wouldn't matter. However, the OpLev beam is hitting the wedged side of the TM so moving in roll would also affect the output of the QPD. Therefore, I tried to keep both IM yaw and IM roll constant while I were actuating pitch of the IM. But, the results show that the TM pitch axis is still not diagonal to the TM yaw axis. I gave up on this method and switched to the power spectrum instead.

The simulation results I obatined from Enzo suggest the resonances frequencies of the TM yaw are ~1 Hz and ~1.5 Hz while the of TM pitch are ~0.85 Hz and ~5 Hz. I measured the power spectrum of the TM yaw and pitch diagmon at assuming a rotational transformation of -2.59 degrees (pwspec_angle_-2_59.png) which is the original guess (see klog xxxx). As can been see from the plot, there are some Y2P and P2Y couplings hence it is crystal clear that this is not the correct transformation we wanted. And then, I did a few guesses and finally concluded that the angle of rotation should be in between 2-4 degrees. After that, I started to look for the sweet spot where there is no observable couplings. After 14 hours of trial and error, I obtained 40 something number of power spectrums corresponding to different rotational transformation from OpLev to Euler's angle. The conclusion I can make from the results is that it appears that the rotational transformation matrix that can completely decouple pitch and yaw does not exist. I can either elminate Y2P coupling or P2Y coupling, but not both. Moreover, I found inconsistency in my results. At one point, I measured the power spectrums using one OL2EUL matrix and found that it looked quite nice since it looked like as if the two freedoms were not coupled at all. But when I double check, it looked like they are coupled again. And when I tweak and try different matrice, I found another matrix that worked quite well but then failed later. At some point I realized that I was tweaking the matrix with changes in order of 10^-4 or even 10^-5 which wouldn't have significant effect at all. So, I decided to stop and say that 2.8 degrees is the rotational transformation. The OL2EUL matrix is[0.9120181 -0.04490822; 0.0578104 1.19005147] for now (see OL2EUL_MEDM_08_20_2018.png and see pwspec_angle_2_8b.png for the corresponding power spectrum). I will also attach all power spectrums in I measured in zip format just for reference (see SR3_TM_OPLEV_PWSPEC_08_19-20_2018.zip). The formating of naming for the power spectrums is pwspec_angle_i_jk.png where i_j is the angle in degrees i.j and k is just another index to denote the same measurement that is done later at some time.