Determining the Effect of Acoustic Coupling on Advanced LIGO

Katherine Banowetz
Mentor: Robert Schofield

Advanced LIGO is built to be extremely sensitive to movements of the test mass as small as $10^{-20}\ \mathrm{m}/\sqrt{\mathrm{Hz}}$, which allows many signals other than gravitational waves to be detected by the system. Pressure created by external sound can alter the differential arm movement measurement by creating Doppler shifts, intensity fluctuations, and scattering in the laser beam. To determine the areas affected by external sound, we inject acoustic noise in the laser and vacuum equipment area. On a smaller scale, vibrating a horizontal access module or beam splitter chamber with a shaker tests the effect of sound on single chambers. To calculate the scale at which these vibrations affect the differential arm movement signal as well as the effect of other environmental injections, I created a Python program. This program analyzes ambient background noise signals as well as injections with coupling functions and outputs a file with the estimated differential arm movement effect for each calculated frequency. By calculating the effect of acoustic coupling and other environmental signals with this program, the calculation process will be streamlined and calculation error will be reduced.