

Abstract

The vibrometer enclosure's main focus is to lower the particle count in the atmosphere that can affect a device being measured by the vibrometer. This project was designed, built, and tested. During the design process the program SolidWorks was used to produce a 3D image, then it was used to produce drawings that would be used to actually build the enclosure. When testing the enclosure the particle counter counted particles sizes of 0.5 μm , 0.7 μm , 1 μm , 3 μm , and 5 μm ten times. An average of the measurements of each particle size was taken to find an estimate of how many particles there were in the room and the enclosure. From the data, it was concluded that the enclosure did reduce the number of particles in the atmosphere by a factor of three, and up to a factor of 20 on the largest particle.

Background

Micro-Electro-Mechanical-Systems (MEMS) Resonators

A resonator is a device that oscillates at a single frequency. These resonators are used in wireless devices. MEMS resonators have frequencies in the giga-hertz, and are not being used in wireless devices because they are purely in the research phase.

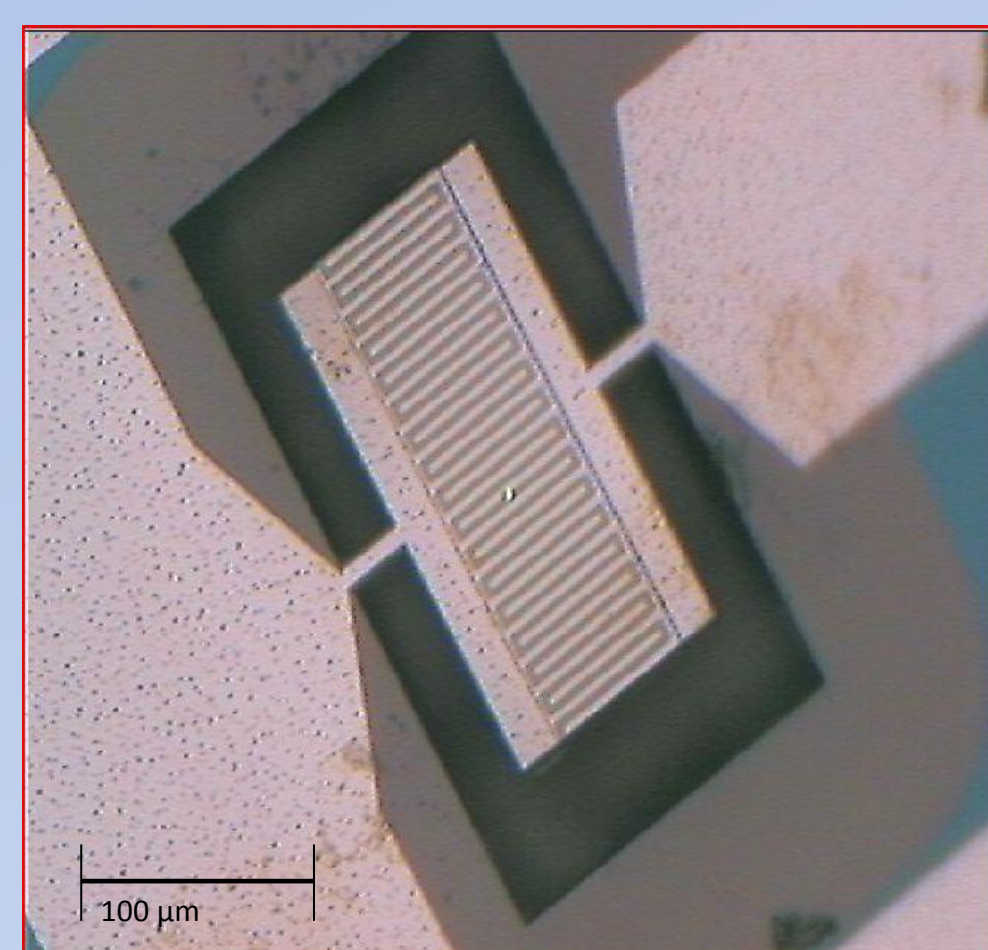
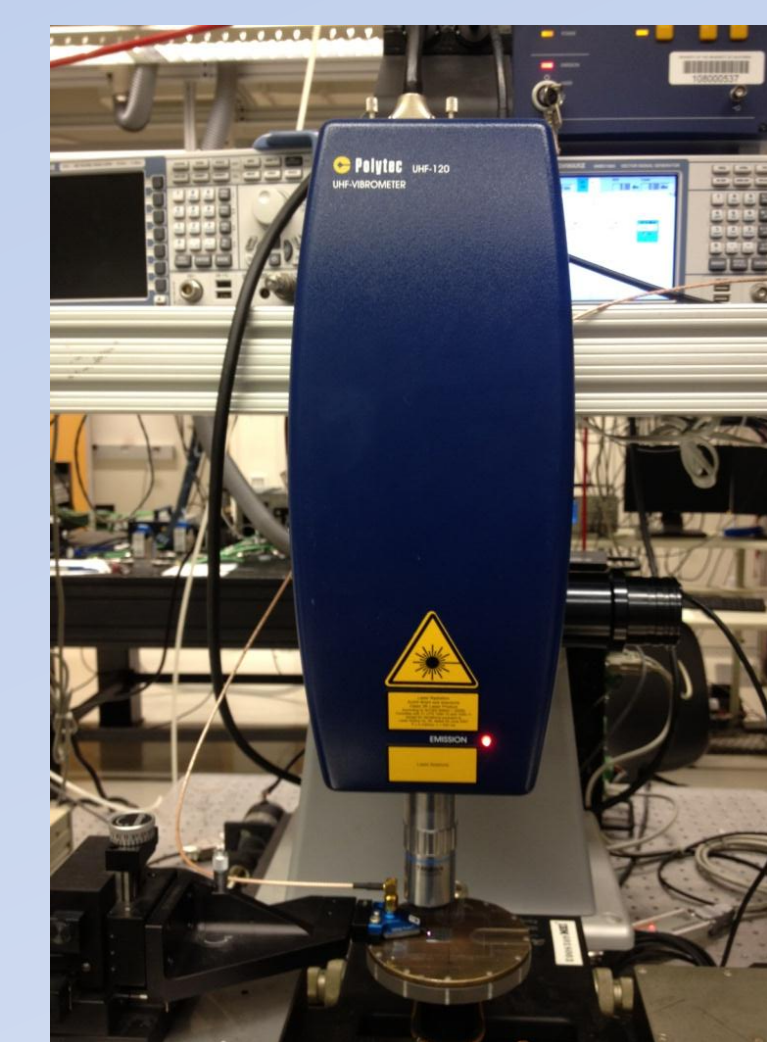


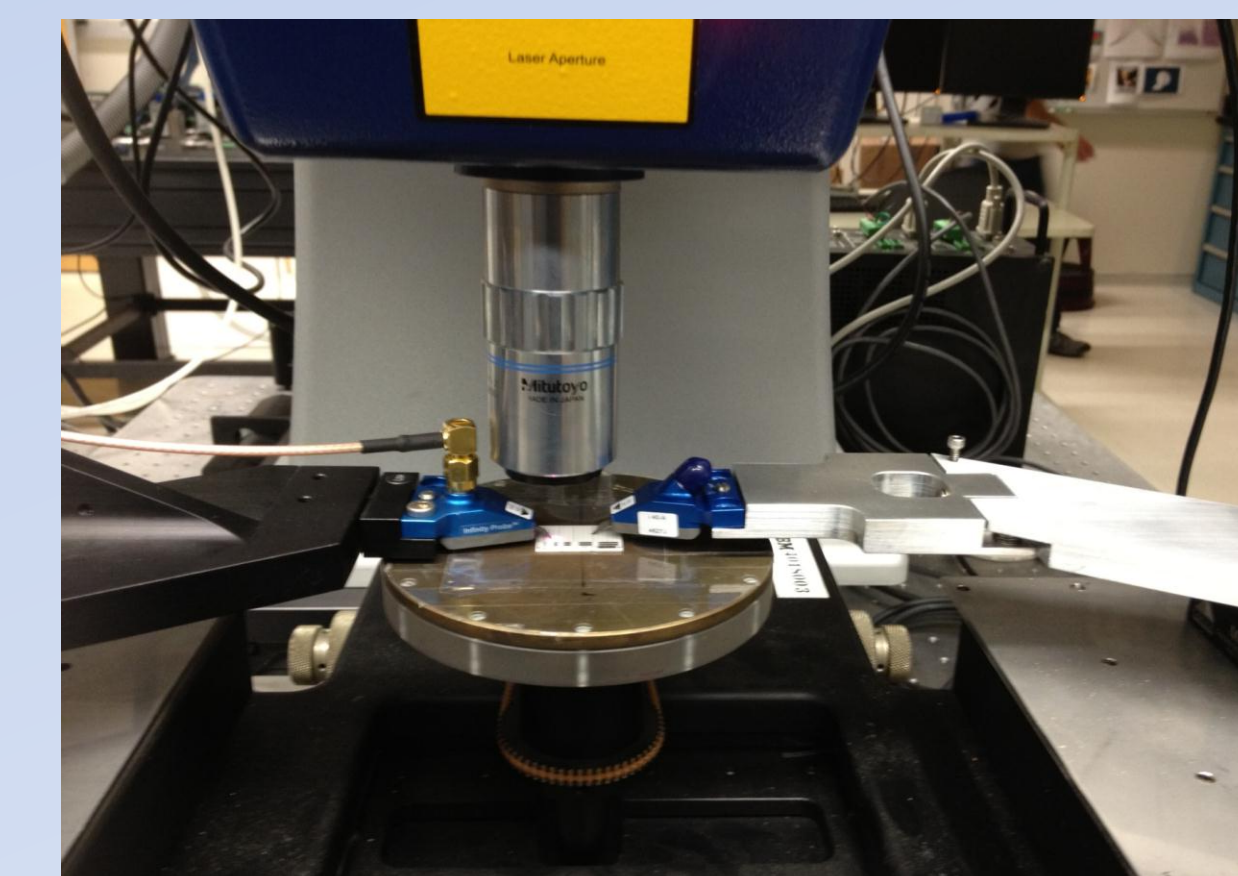
Figure 1 A 1 GHz Piezoelectric MEMS Resonator.

Vibrometer

A vibrometer uses the Doppler effect to find the displacement of the resonators. MEMS resonators have displacements down to the picometer. Figure 2(b) illustrates how MEMS resonators are exposed directly to dust and particles in the air. My project aims to solve this problem.



(a)



(b)

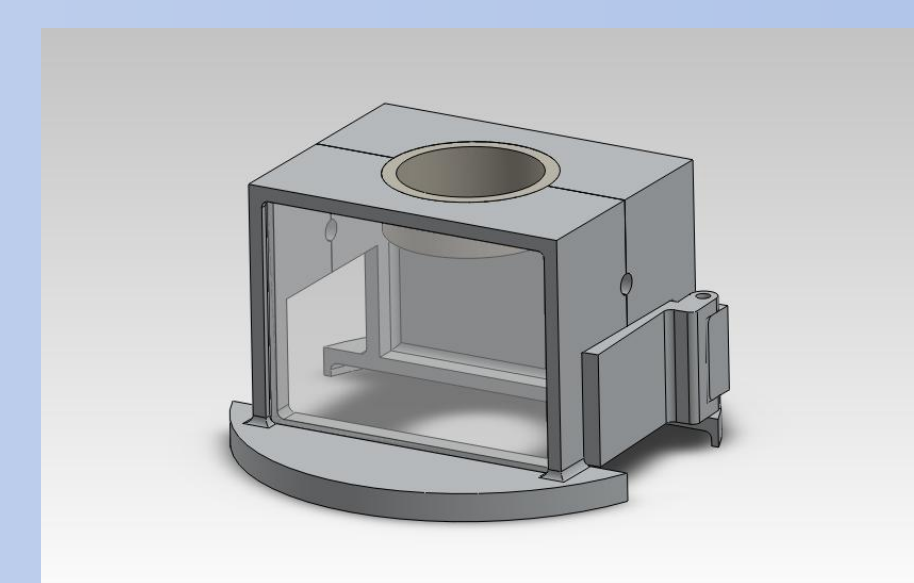
Figure 2 (a) Polytec UHF-120 Vibrometer with electrical probe station. (b) Complete Vibrometer setup to measure MEMS resonator.

Design

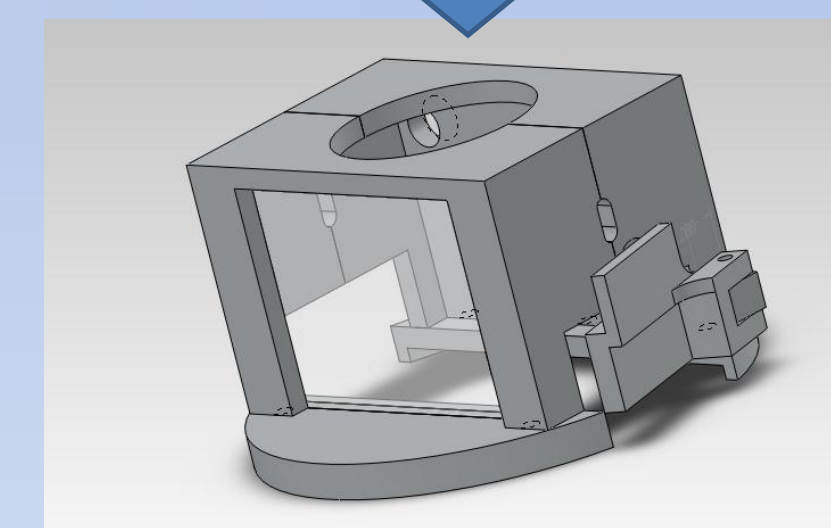
- During the design process the program SolidWorks was used to produce a 3D image of each part. It was then it was used to produce drawings that would be used to actually build the enclosure.
- The design process consisted of ten steps, which were a reiterative process of review and change to the design.

Design Process

1. Have an idea.
2. Use requirements to shape your idea
3. Review from user
4. Institute any changes to the design
5. Manufacturing review
6. Institute any changes to the design
7. Check that design meets requirements
8. If step 7 is no then go back to step 1, if yes then continue
9. Build final design
10. Test design



Step 4



Step 6

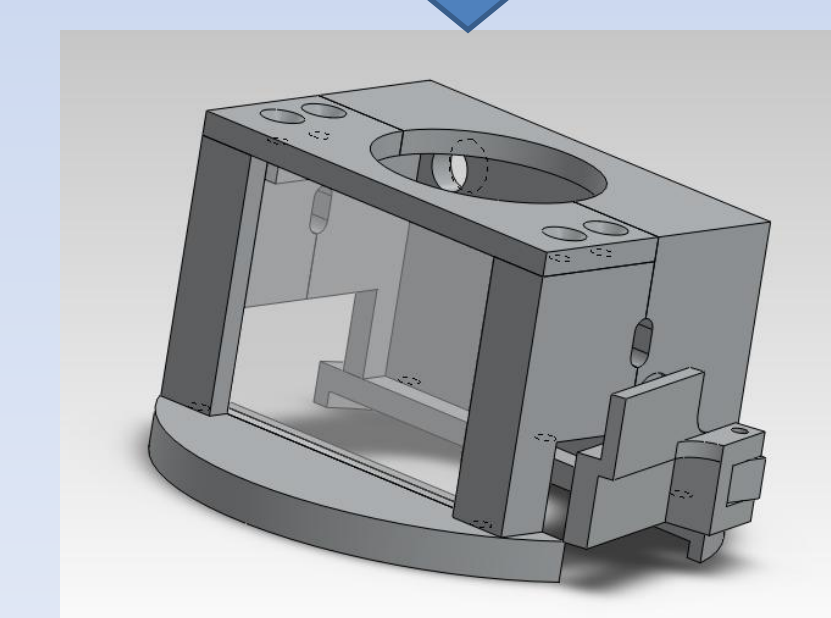


Figure 3 Illustration of how the 3D images changed when the reviews were made. The top image has the base and the top half as one piece. The middle has both the base and the top as separate pieces, as well as an extension in the door. The bottom image even further separates the top piece into three pieces.

Building

The machining took place in the Engineering Machine Shop. Aluminum was chosen because of the cost and ease to machine. Figure 4 illustrates the flow from an image to a physical part.

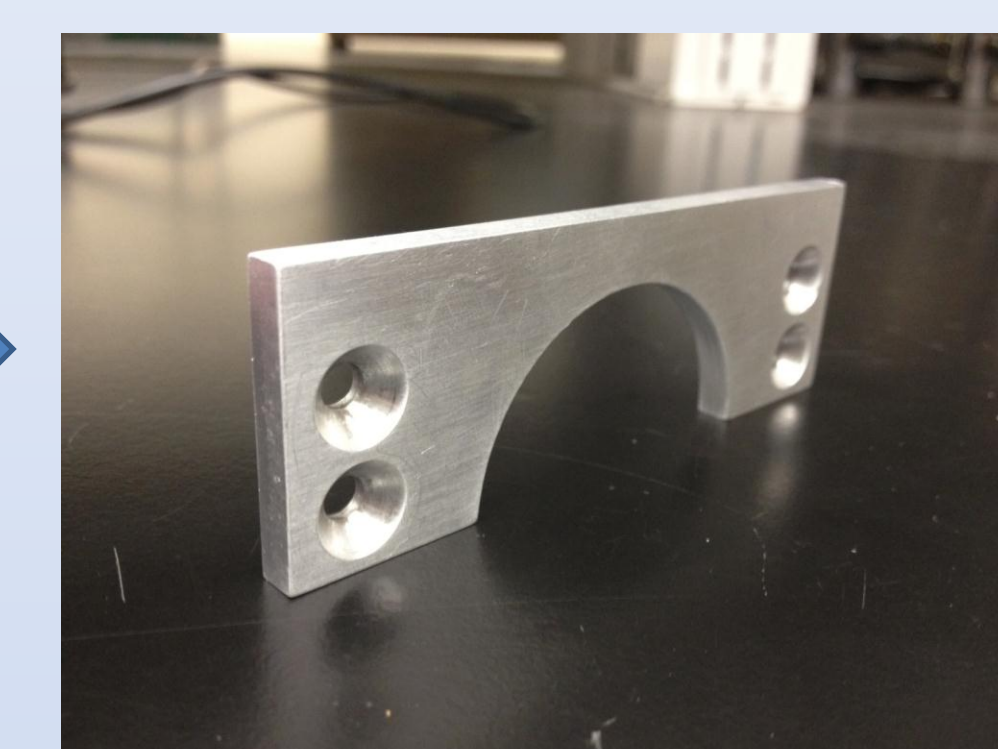
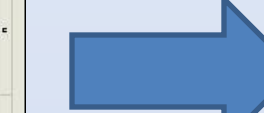
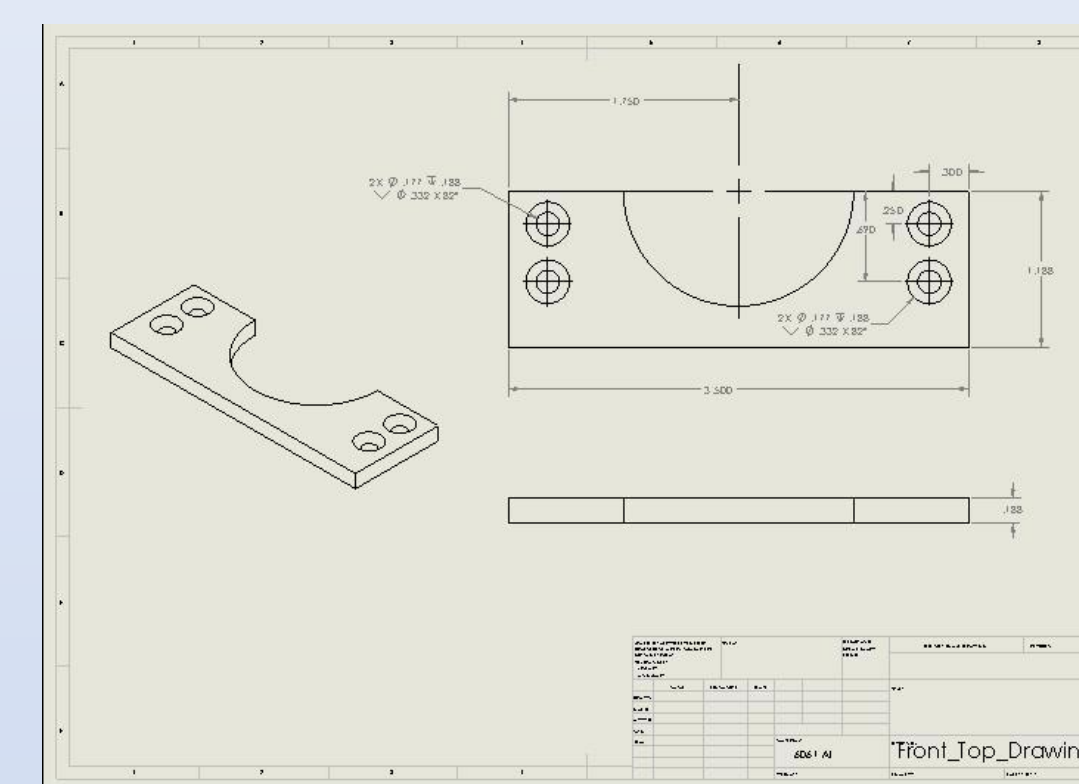
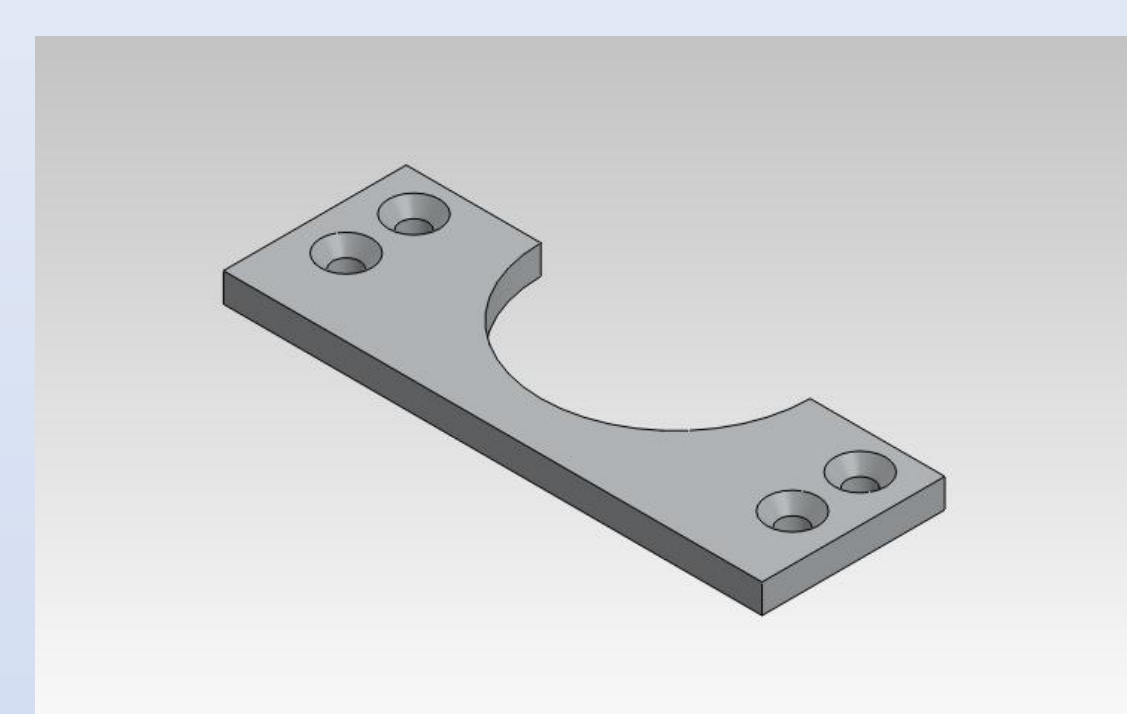


Figure 4 The flow from a 3D image from SolidWorks to an actual physical piece. The first image is a 3D image of a piece, then flows to a drawing also formed in SolidWorks. Last image is a machined piece.

Testing

Setup

- The nitrogen line pumps out nitrogen gas into the enclosure.
- The particle counter counts how many particles there are in the air inside the enclosure.
- This experiment was performed ten times for each particle size, and an average was taken.

Results

- From Table 1 it can be concluded that the enclosure did reduce the number of particles
- As the particles got larger it had a greater reduction.
- Figure 6 illustrates how "clean" the Lab and enclosure are.

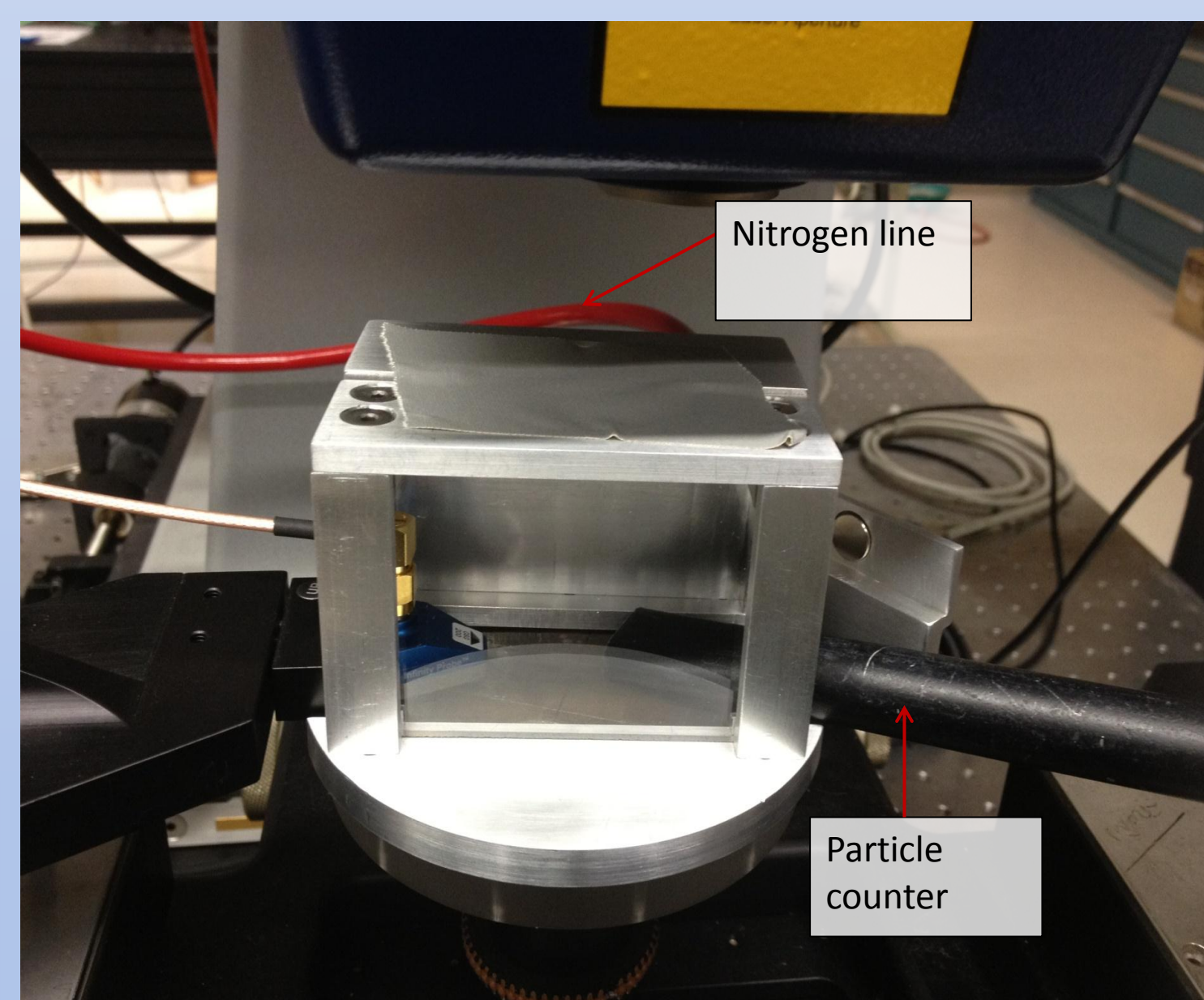


Figure 5 The experimental setup of the enclosure.

Table 1 Average number of particles in lab and enclosure. The reduction from the enclosure.

Size (μm)	Lab Room particle/ m^3	Enclosure particle/ m^3	Reduction Factor
0.5	2,248,591	780,419	~3
0.7	718,088	205,390	~3
1	412,193	106,368	~4
3	10,842	1,130	~10
5	4,803	177	~20

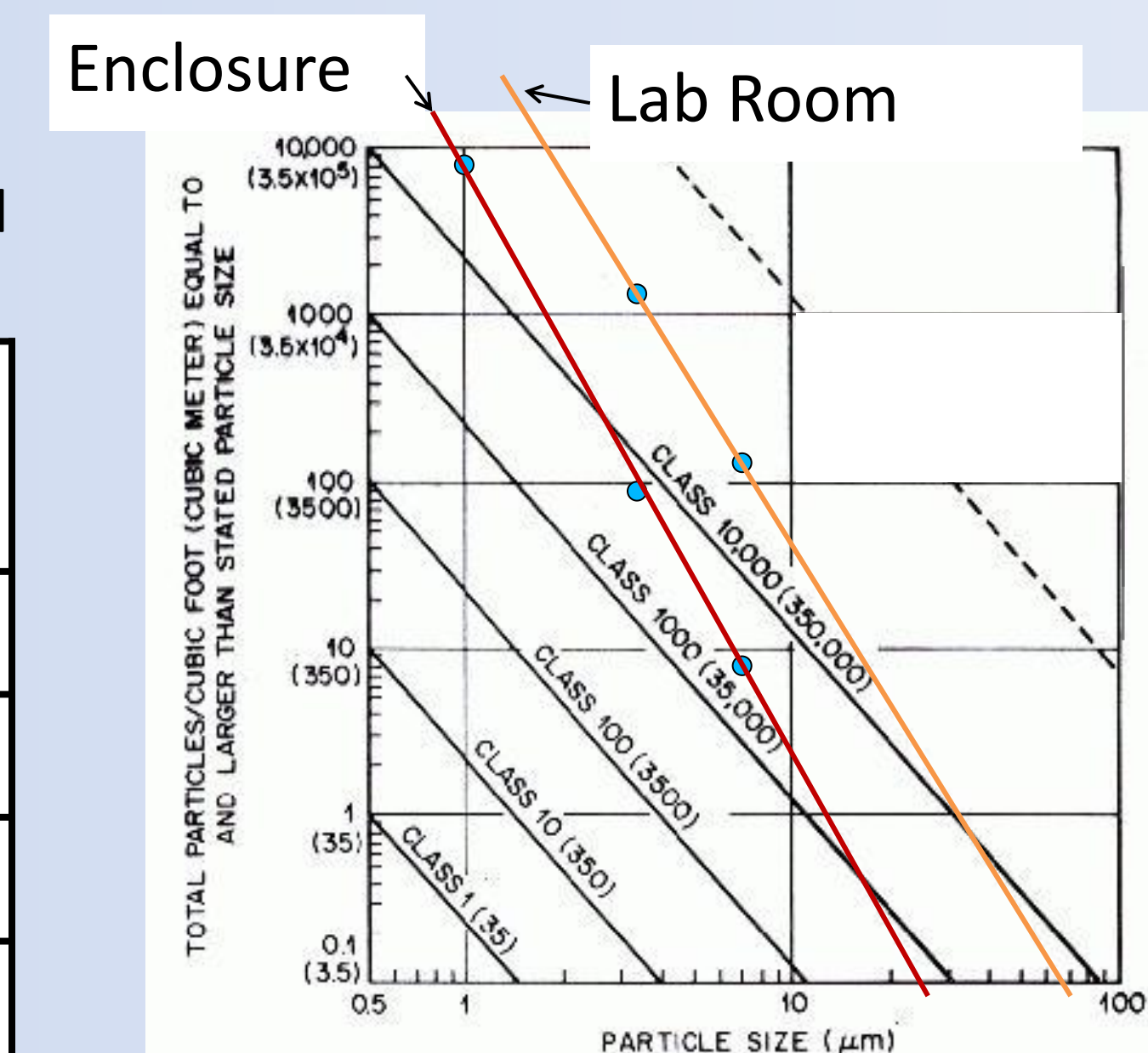


Figure 6 Graph of number of particles vs. particle size. Lab room and enclosure are roughly graphed.