

SupplementaryMaterials: Optical Beam Deflection Based AFM with Integrated Hardware and Software Platform for Undergraduate Engineering Laboratory

Siu Hong Loh and Wei Jie Cheah

1. General Information on the Custom-Built Mechanical Parts

The main purpose of the custom-built mechanical parts is to incorporate off-the-shelf optomechanics components as mentioned in the manuscript. All parts should be attached together firmly so that important tasks such as laser alignment and tip engagement can be performed precisely. At the same time, the designs of these custom-built parts are kept as simple as possible. In this supplementary material, detailed drawings of all custom parts are shown (Figures S2–S14). Next, assembly details for different sections are illustrated from Figure S15 to Figure S17. Lastly, design consideration for the cantilever holder is discussed in Section 2 along with detailed mechanical drawings.

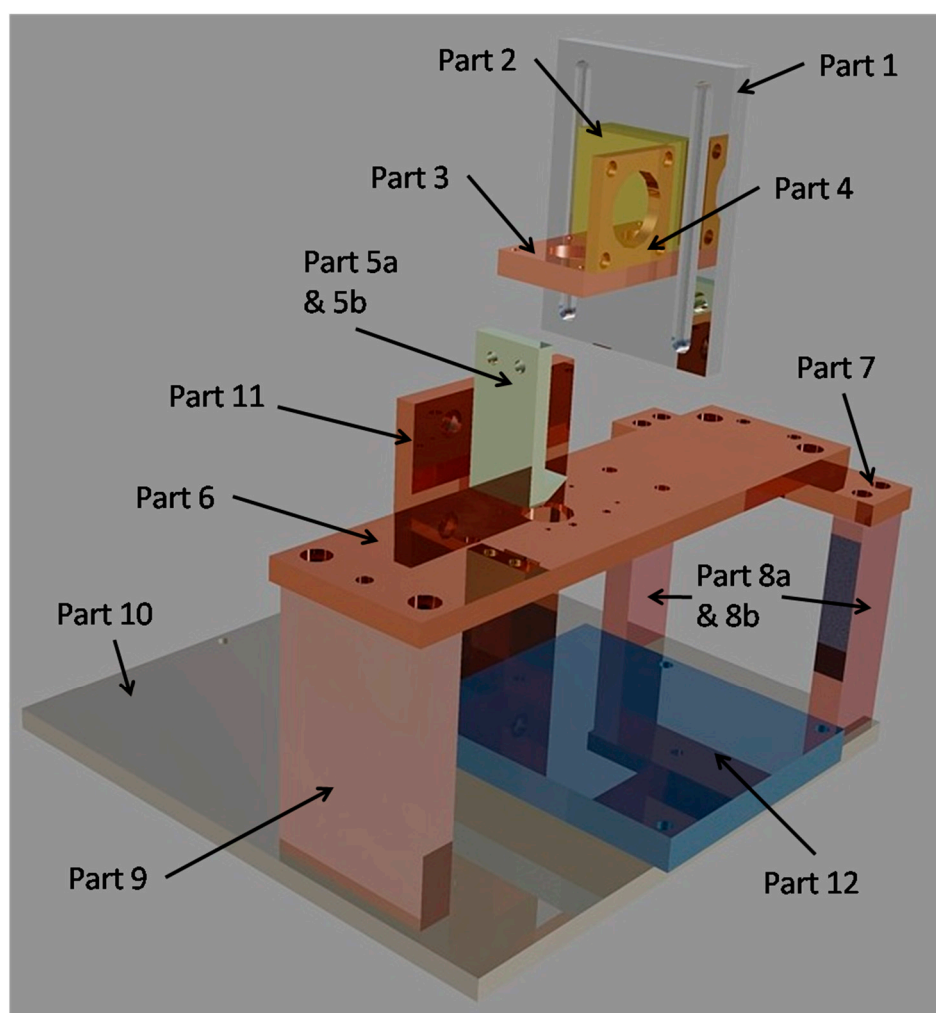


Figure S1. Parts listing for the custom-built mechanical parts of the developed atomic force microscope (AFM). For clarity purpose, off-the-shelf components are omitted in the diagram.

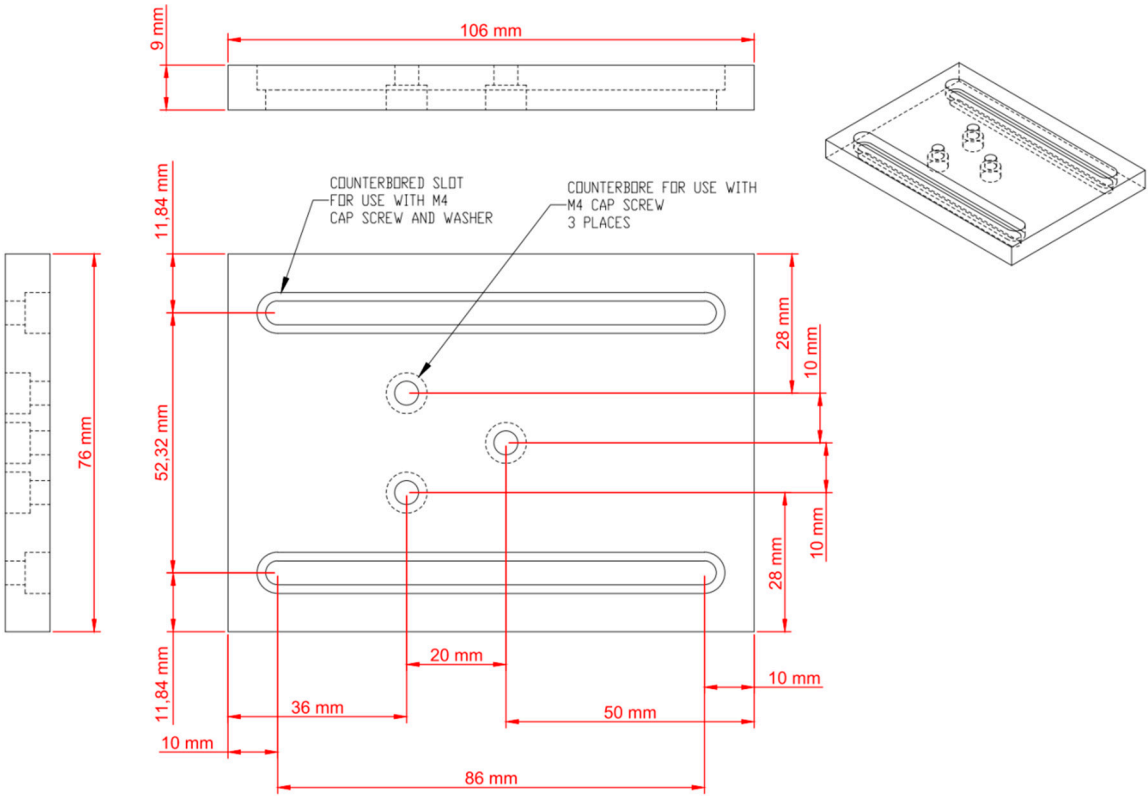


Figure S2. Detailed mechanical drawing of Part 1 from Figure S1.

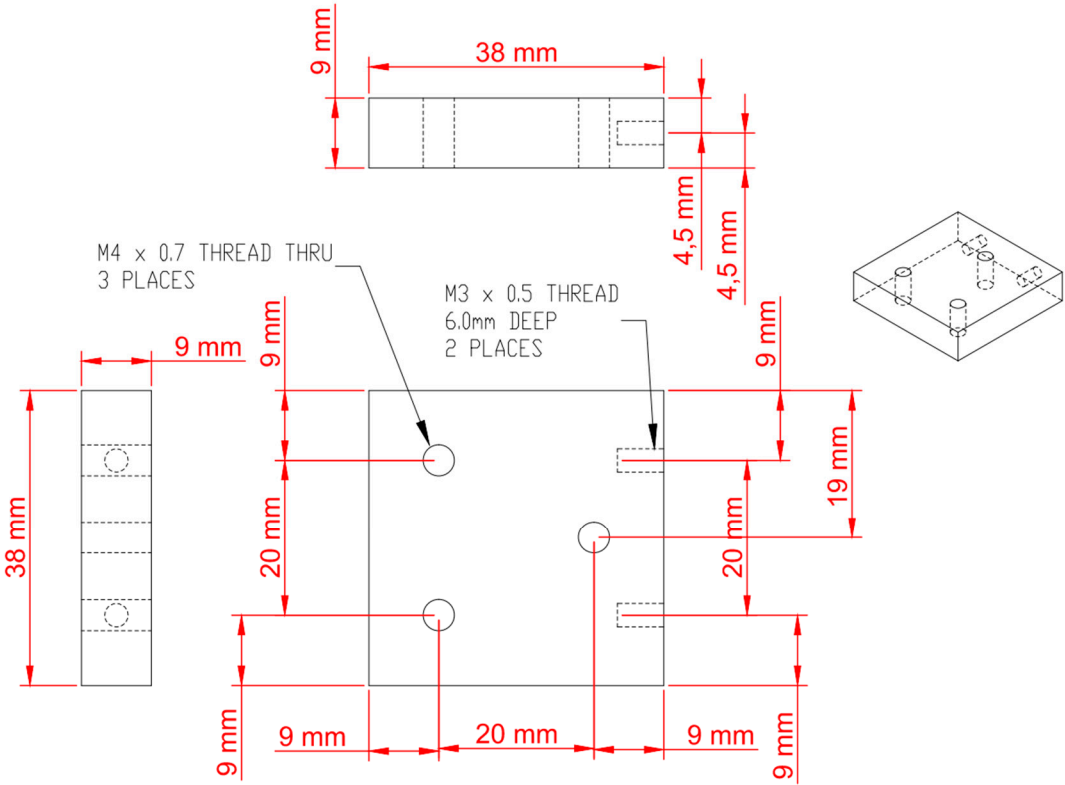


Figure S3. Detailed mechanical drawing of Part 2 from Figure S1.

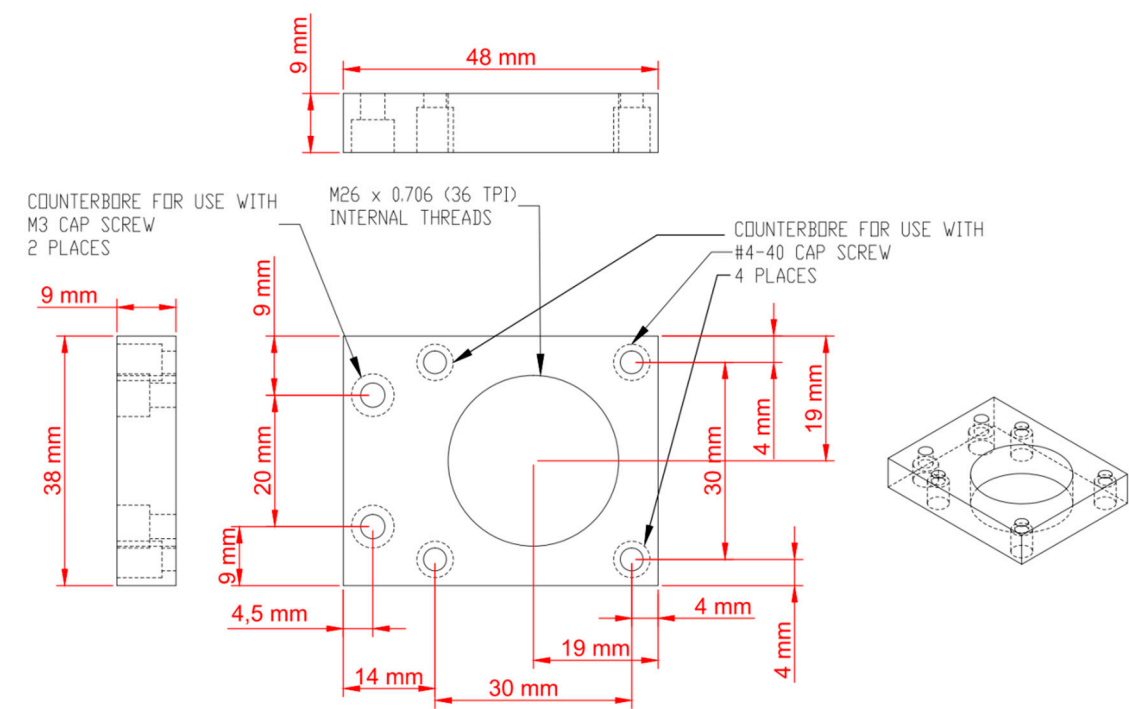


Figure S4. Detailed mechanical drawing of Part 3 from Figure S1.

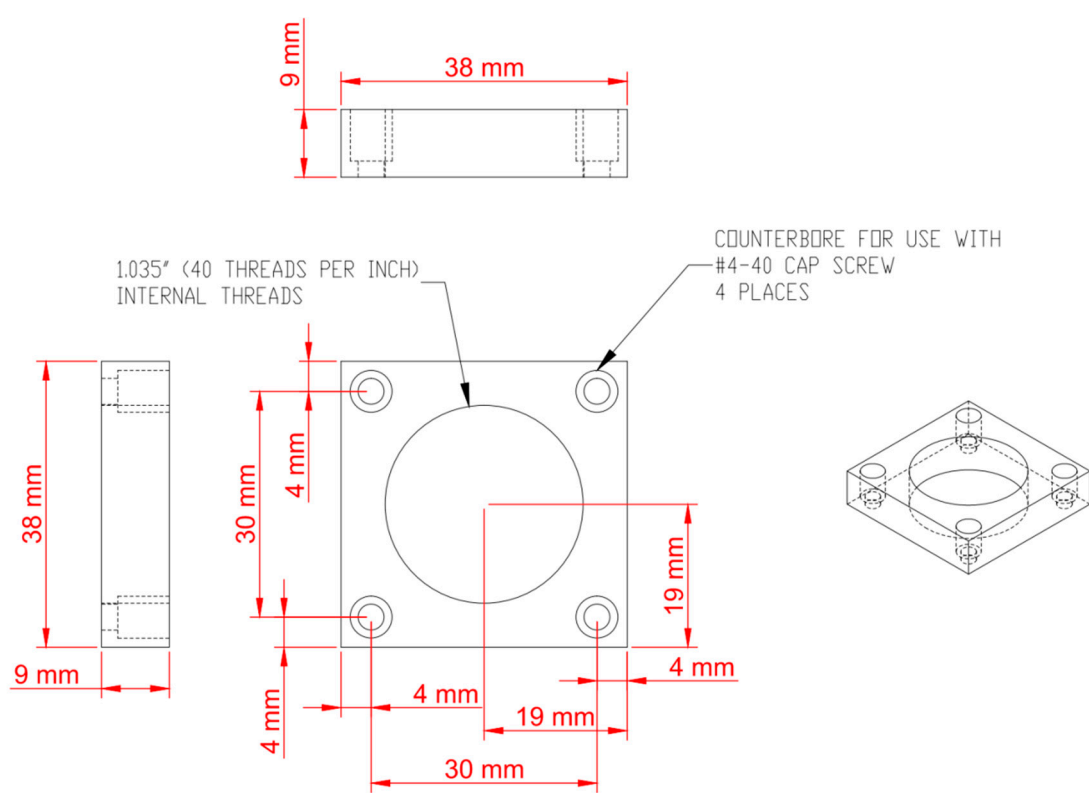


Figure S5. Detailed mechanical drawing of Part 4 from Figure S1.

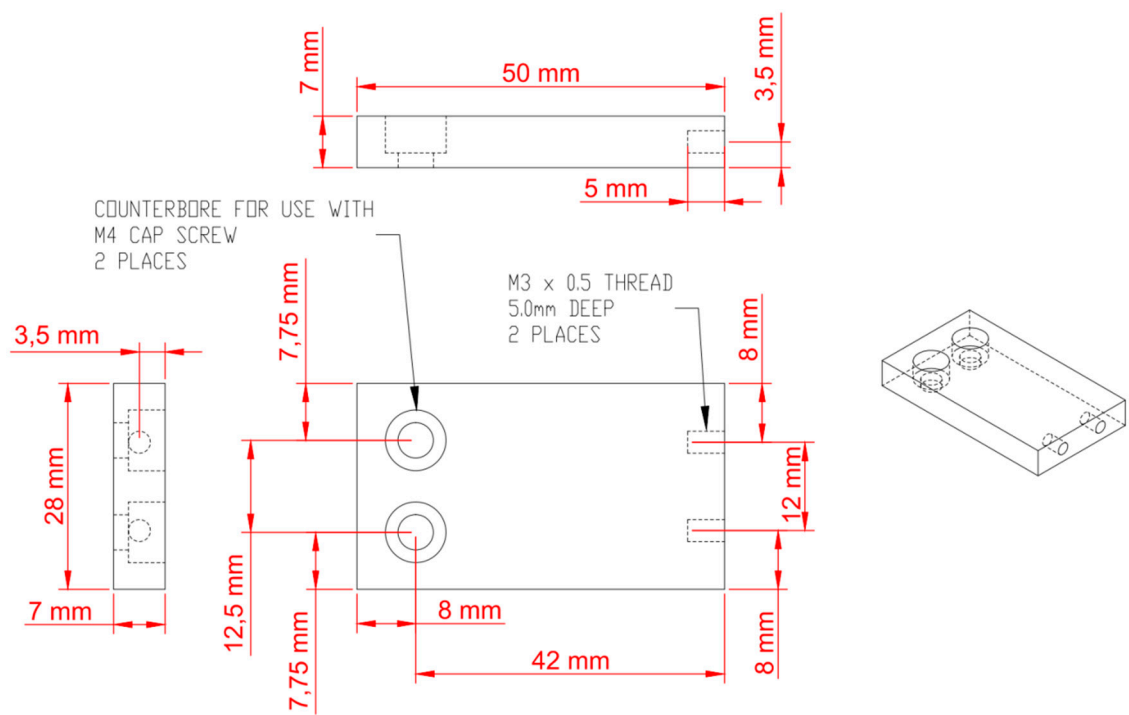


Figure S6. Detailed mechanical drawing of Part 5a from Figure S1.

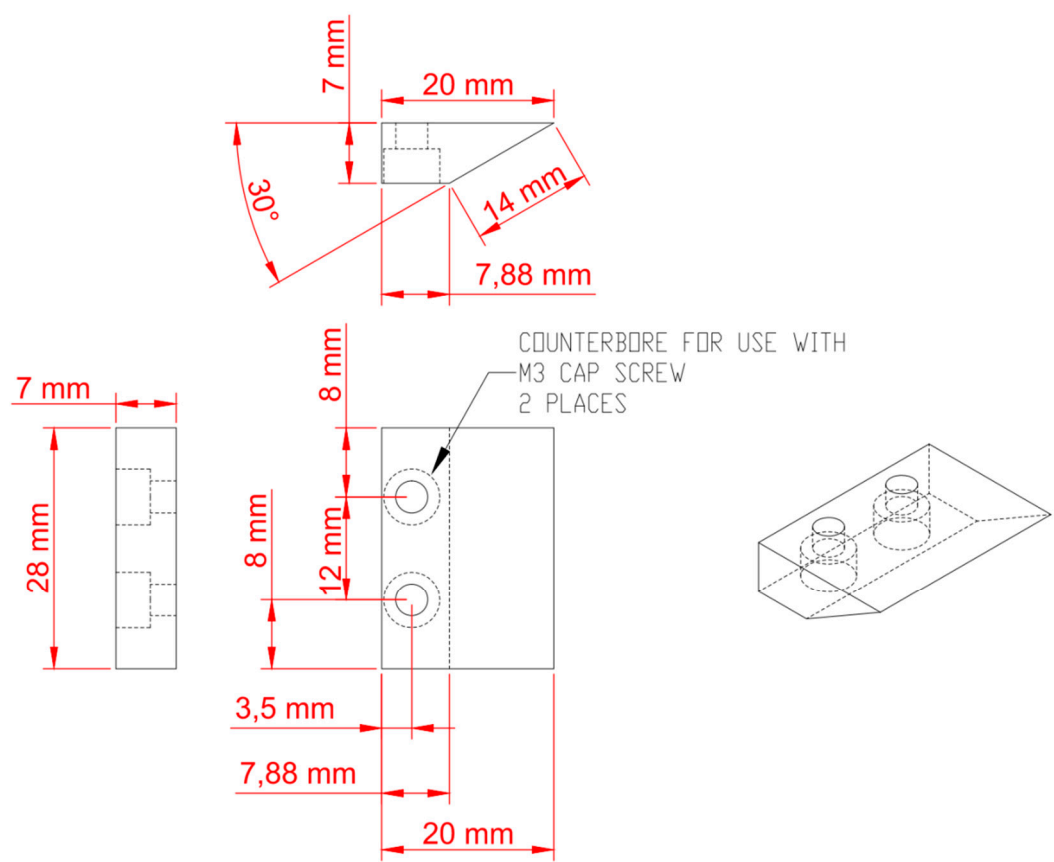


Figure S7. Detailed mechanical drawing of Part 5b from Figure S1.

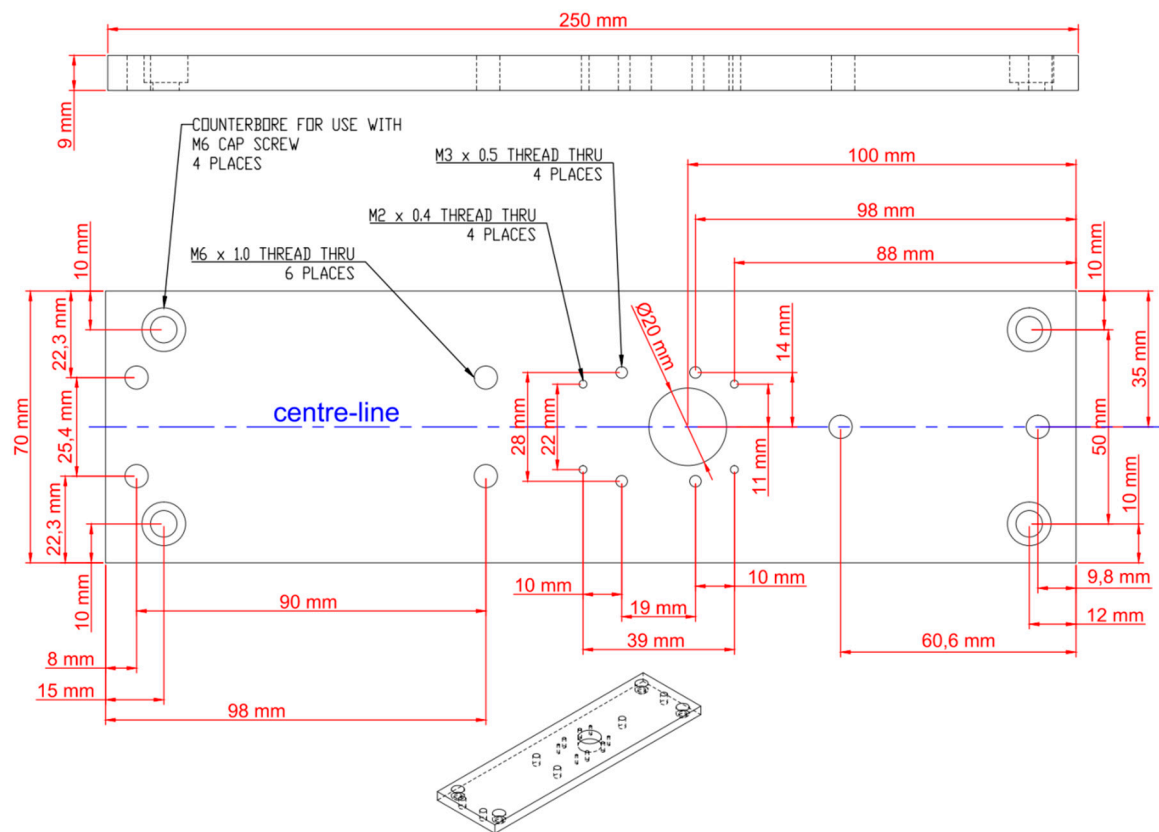


Figure S8. Detailed mechanical drawing of Part 6 from Figure S1.

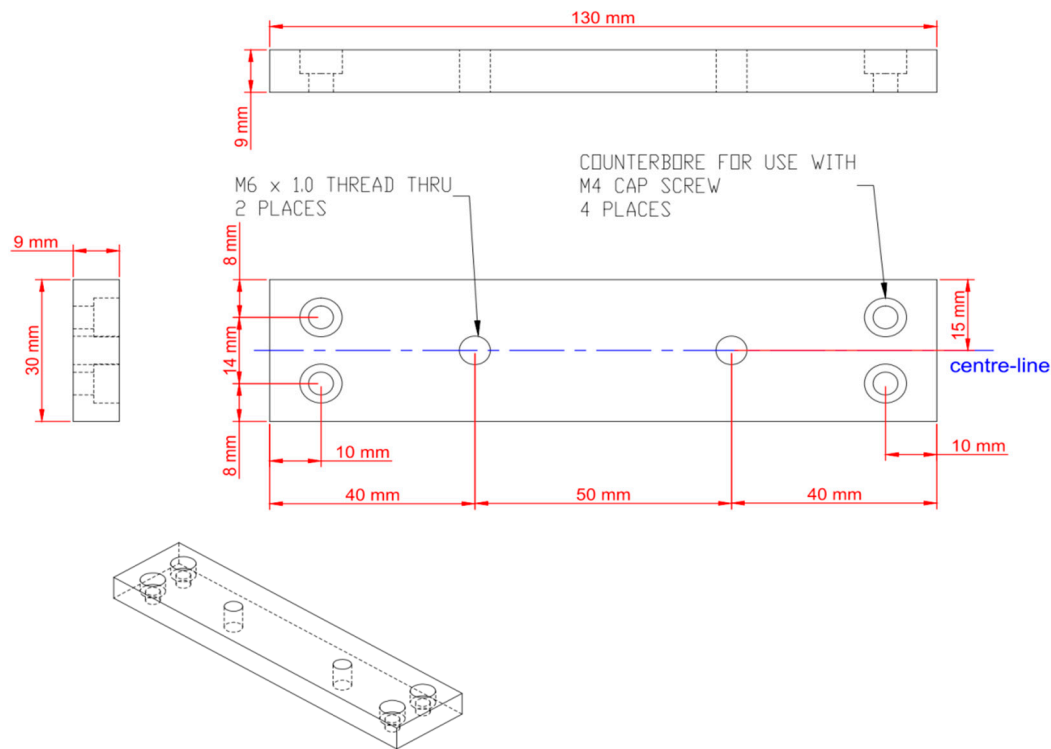


Figure S9. Detailed mechanical drawing of Part 7 from Figure S1.

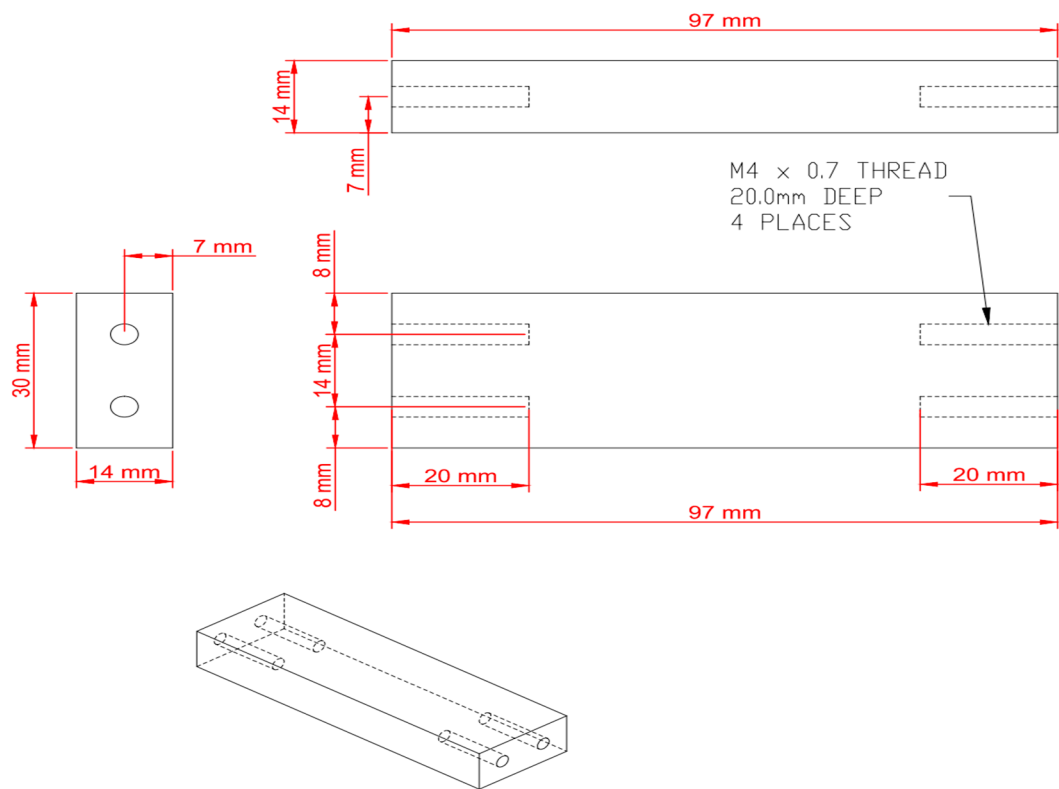


Figure S10. Detailed mechanical drawing of Part 8a and 8b from Figure S1. Part 8a and 8b are identical.

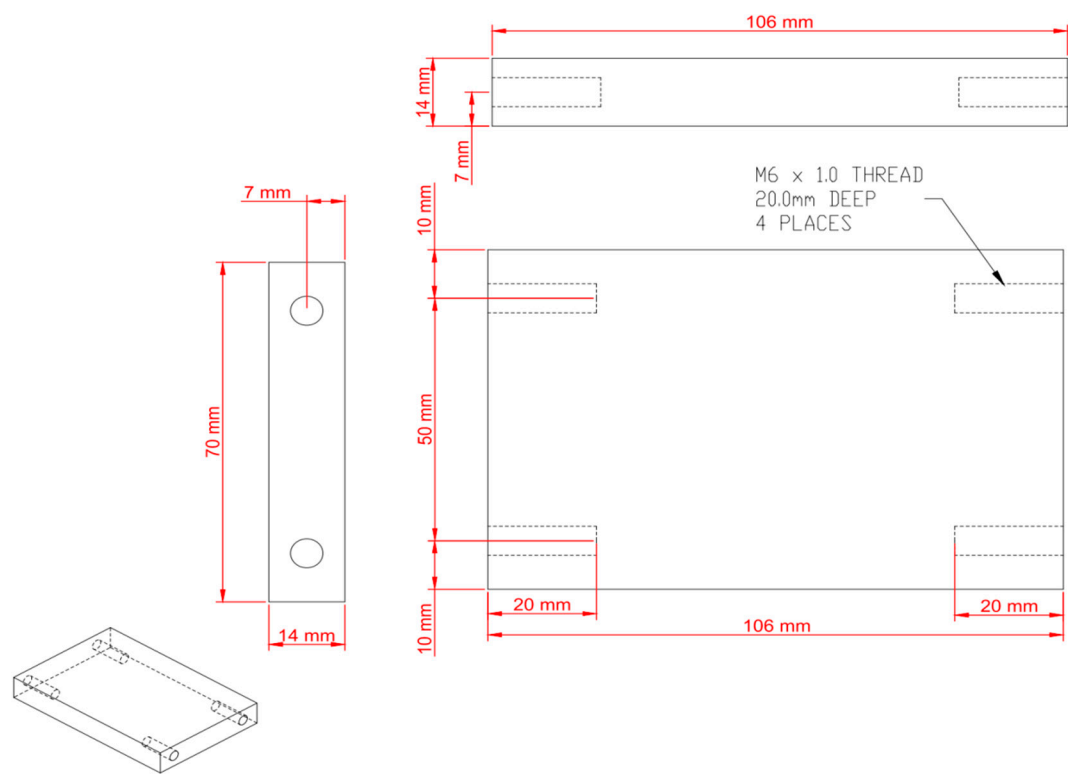


Figure S11. Detailed mechanical drawing of Part 9 from Figure S1.

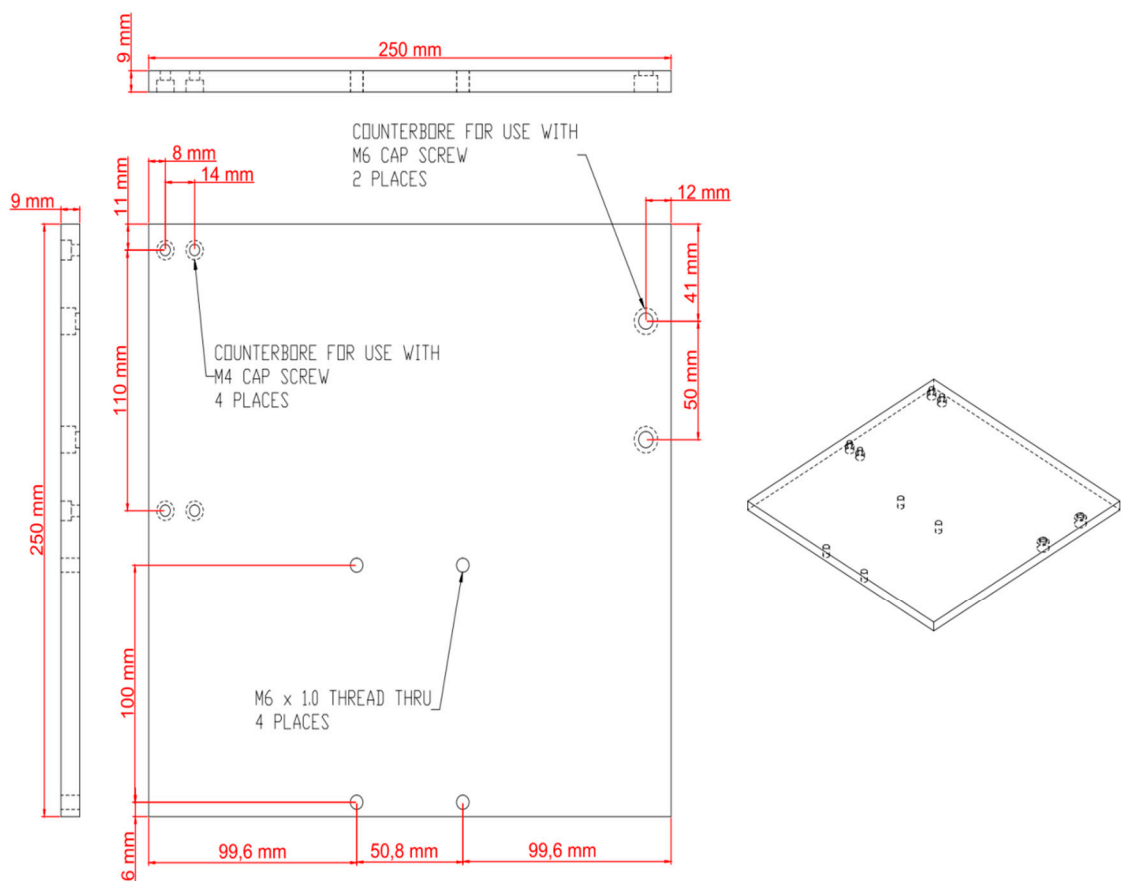


Figure S12. Detailed mechanical drawing of Part 10 from Figure S1.

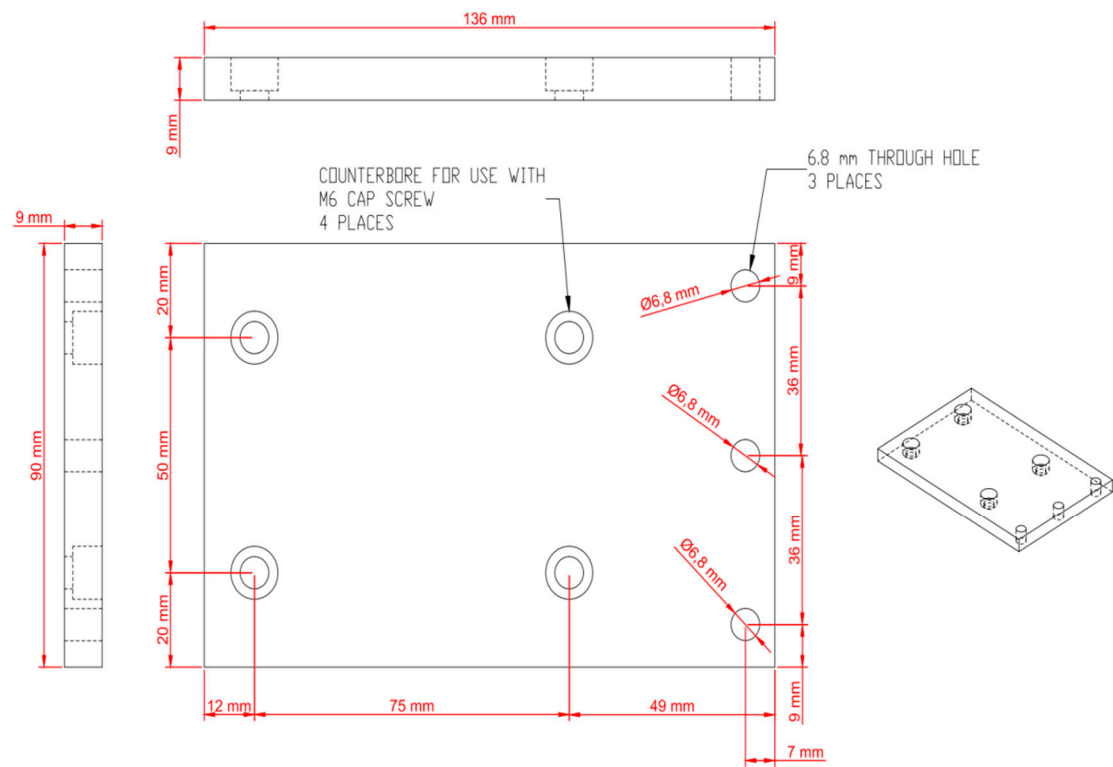


Figure S13. Detailed mechanical drawing of Part 11 from Figure S1.

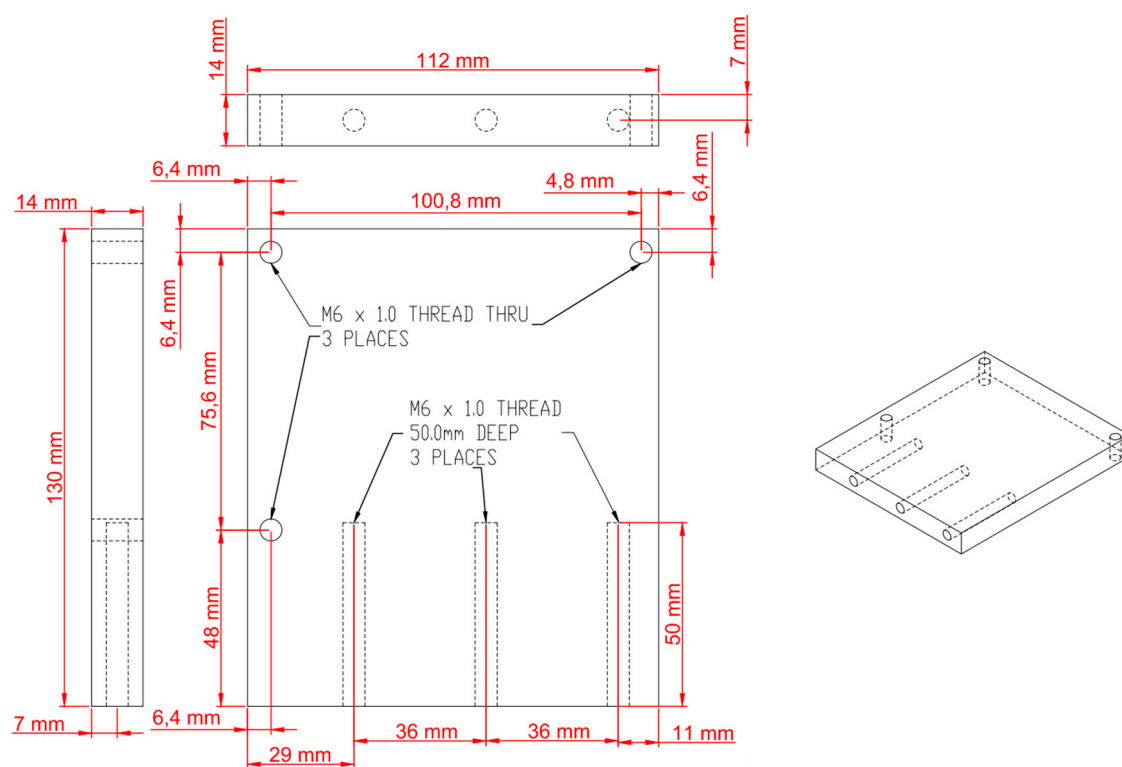


Figure S14. Detailed mechanical drawing of Part 12 from Figure S1.

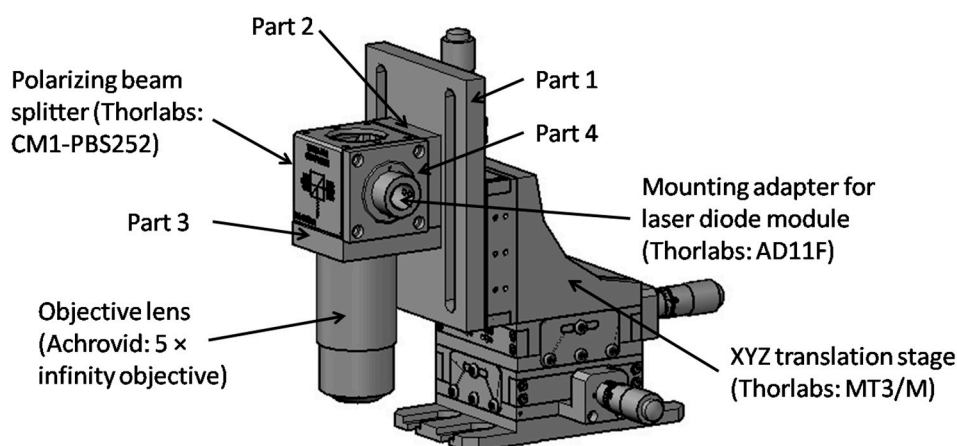


Figure S15. The assembly detail for the section consisting of a laser diode module, polarizing beam splitter and objective lens. Custom part 1, part 2, part 3, and part 4 are used in this section. Part 1 is attached to the MT3/M translation stage and the height can be adjusted to accommodate different objective lens with various working distances. After part 1 and subsequent parts are fixed, fine-adjustment is accomplished by using the micrometers of the translation stage (X, Y and Z-axes) to focus the laser spot onto the AFM cantilever. A laser diode module (applicable only to housing size with 11 mm diameter) is fixed through the mounting adapter which is attached to part 4.

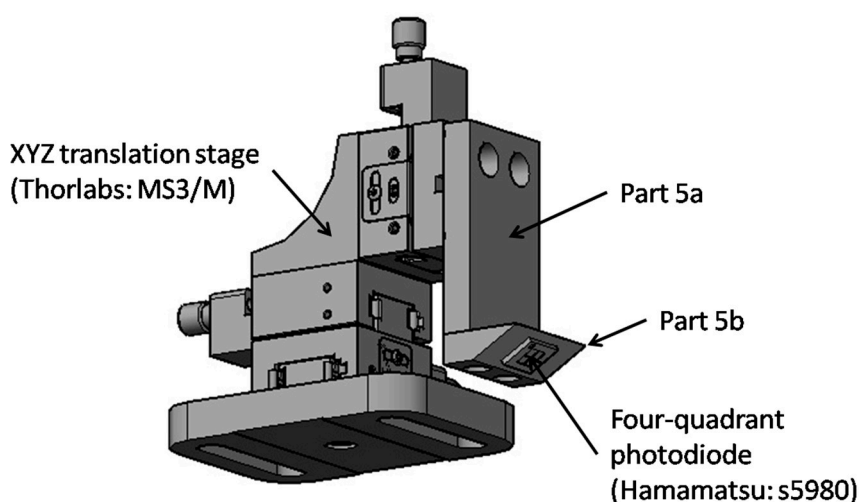


Figure S16. The assembly detail for the section consisting of a photodiode module. Custom part 5a and part 5b are used in this section. The purpose of the two custom parts is to hold the photodiode module. The photodiode module is fixed to part 5b using double sided adhesive tape. Note that for standard practice, the photodiode module should be soldered to small printed circuit board (with wires connected/soldered) prior to this fixing process. The end-mounted adjustment screws (X, Y and Z-axes) of the translation stage are used to align the reflected laser spot (from the back of an AFM cantilever) to the center of the photodiode module.

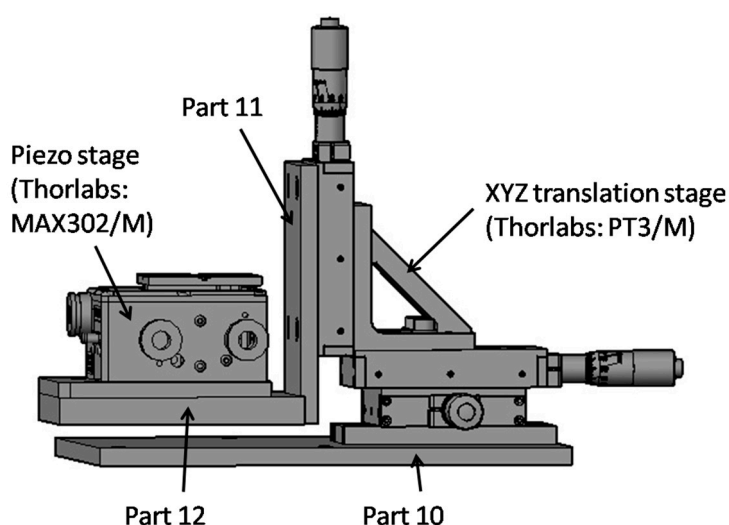


Figure S17. The assembly detail for this section consisting of the piezo stage. Custom part 10, part 11 and part 12 are used in this section. Part 10 is the main base plate for the whole AFM system. The PT3/M translation stage is fixed on part 10. The piezo stage sits on top of part 12 (can be fixed firmly using M6 cap screws). Part 12 is attached to part 11 which in turn is fixed to the translation stage. Prior to image scanning, micrometers for the X and Y axes can be used to locate the area of interest. The micrometer for the Z axis is used to adjust the height of the piezo stage. Therefore, it can be used during the tip engagement process.

2. Design Consideration for the Cantilever Holder

A cantilever holder designed for the AFM system is shown in Figure S18. The holder has four custom parts. For current design, an AFM cantilever can only be attached to the holder using double sided adhesive tape (cut into a very small piece). In order to attach the cantilever holder to the AFM setup, a “bracket” is created and fixed to the bottom of custom part 6 as shown in Figure S19 below. The cantilever holder can be “slided” in or out of the bracket. Detailed drawings of all custom parts of the cantilever holder and the bracket are shown from Figure S20 to Figure S24.

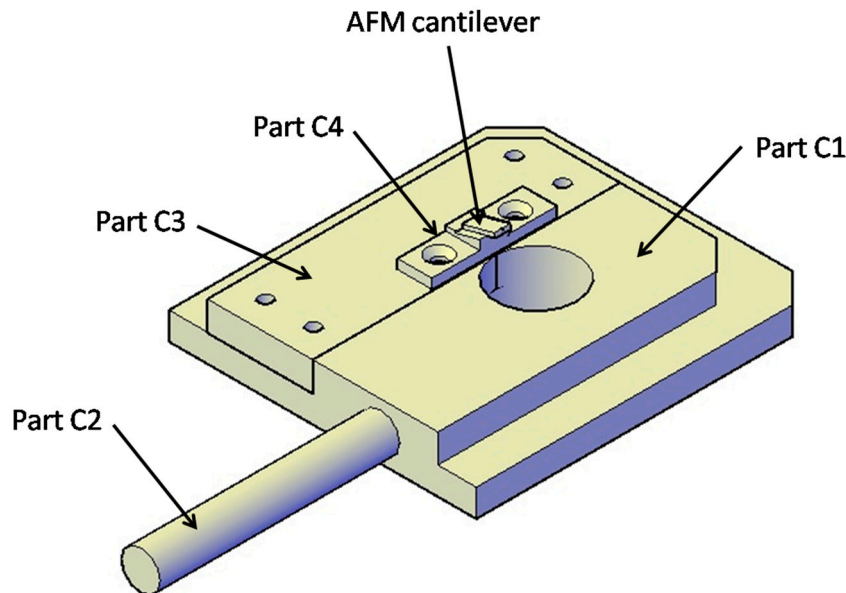


Figure S18. Parts listing for the cantilever holder used in the developed AFM. The cantilever holder consists of four custom parts (part C1, part C2, part C3, and part C4). The AFM cantilever is attached to part C4 with a small piece of double sided adhesive tape.

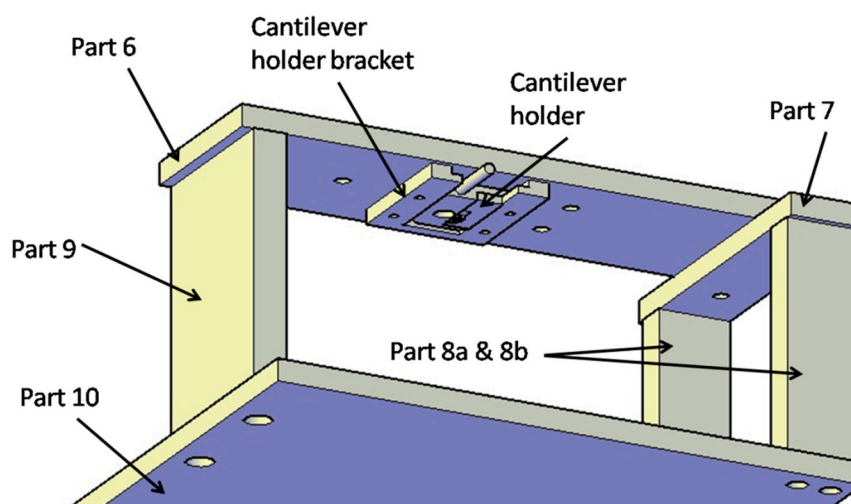


Figure S19. The assembly detail for this section consisting of a cantilever holder and its bracket. The bracket is fixed to the bottom of part 6.

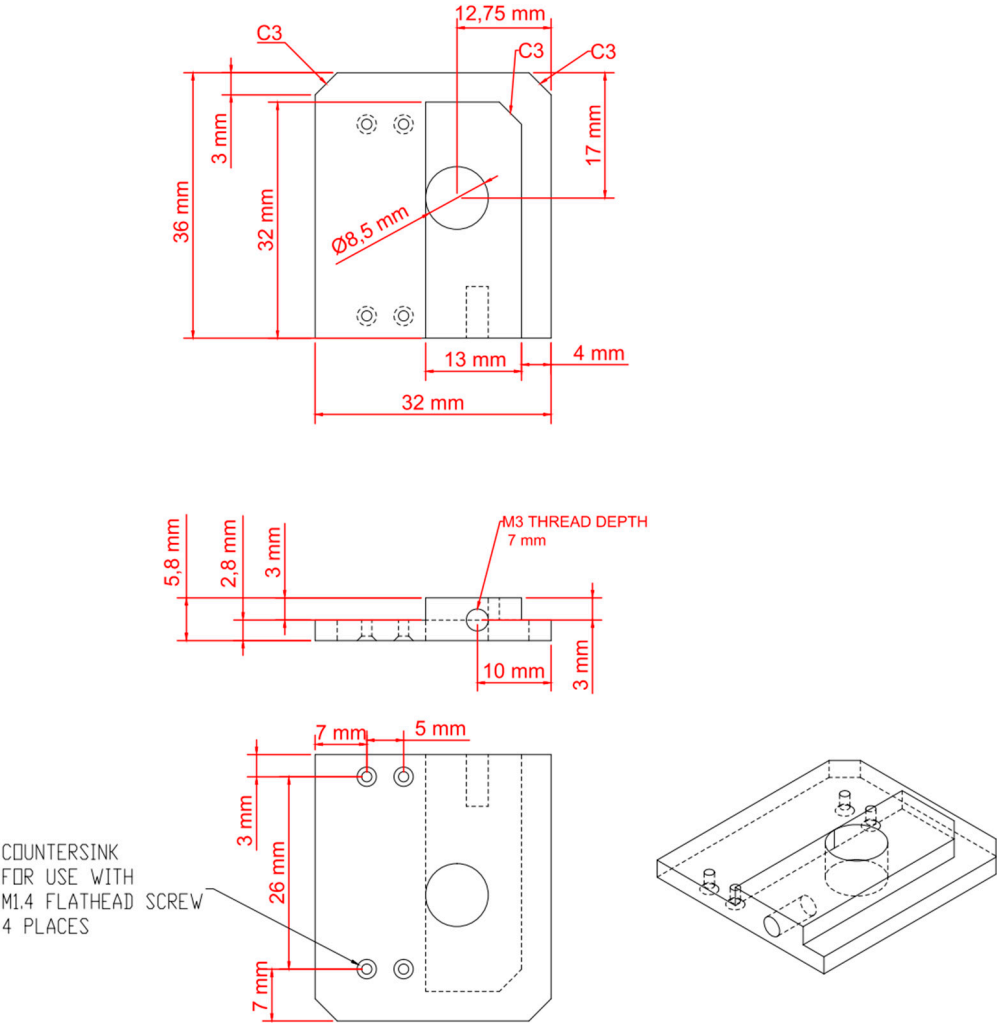


Figure S20. Detailed mechanical drawing of Part C1 from Figure S18.

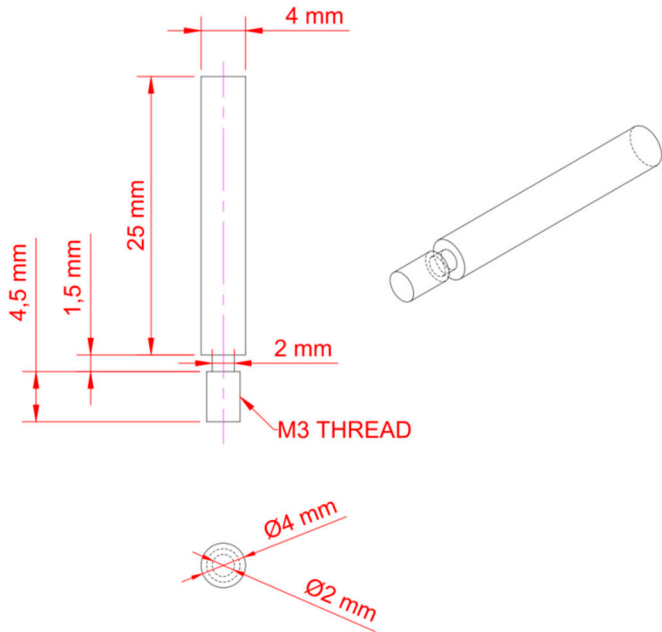


Figure S21. Detailed mechanical drawing of Part C2 from Figure S18.

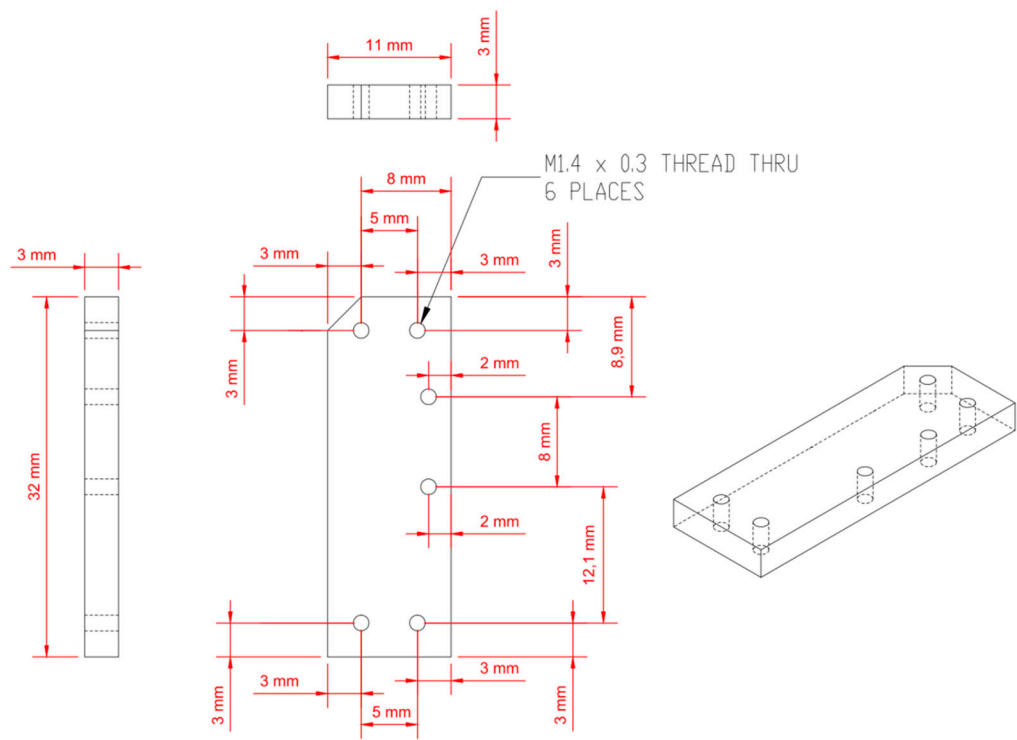


Figure S22. Detailed mechanical drawing of Part C3 from Figure S18.

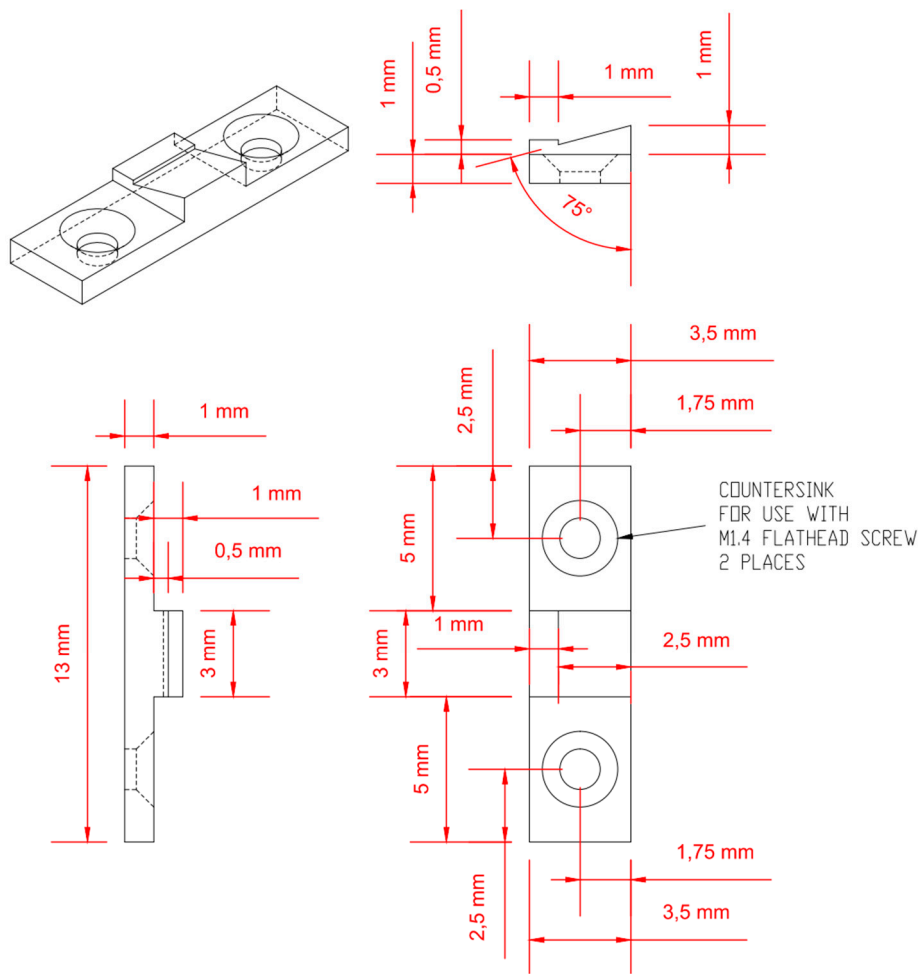


Figure S23. Detailed mechanical drawing of Part C4 from Figure S18.

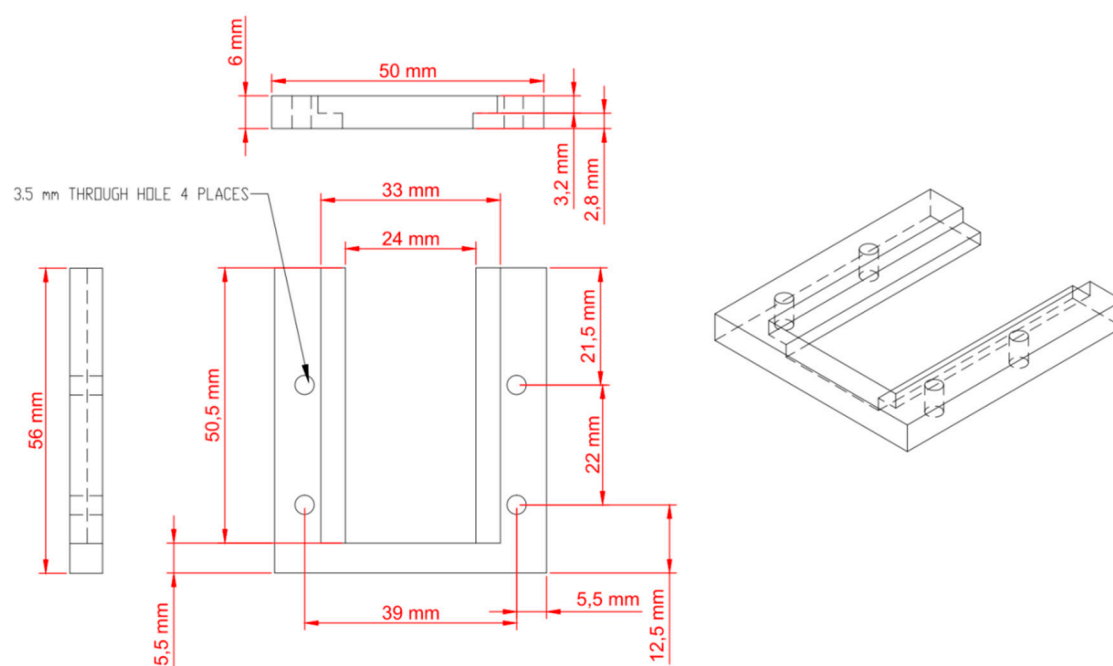


Figure S24. Detailed mechanical drawing of the bracket for the cantilever holder.