

Paul Trap Creation Manual

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1 shielding box

Trapped particles may escape due to the influence of wind. To prevent this, a box is created to shield against the wind.

Parts List

- `shielding_box.stl`¹
- `window.stl`
- M3 screw

Secure them with screws as illustrated in the photo (Fig. 1). Please be aware that the tap has not been cut for the hole in this model (the hole diameter itself is $\phi = 3$ mm).

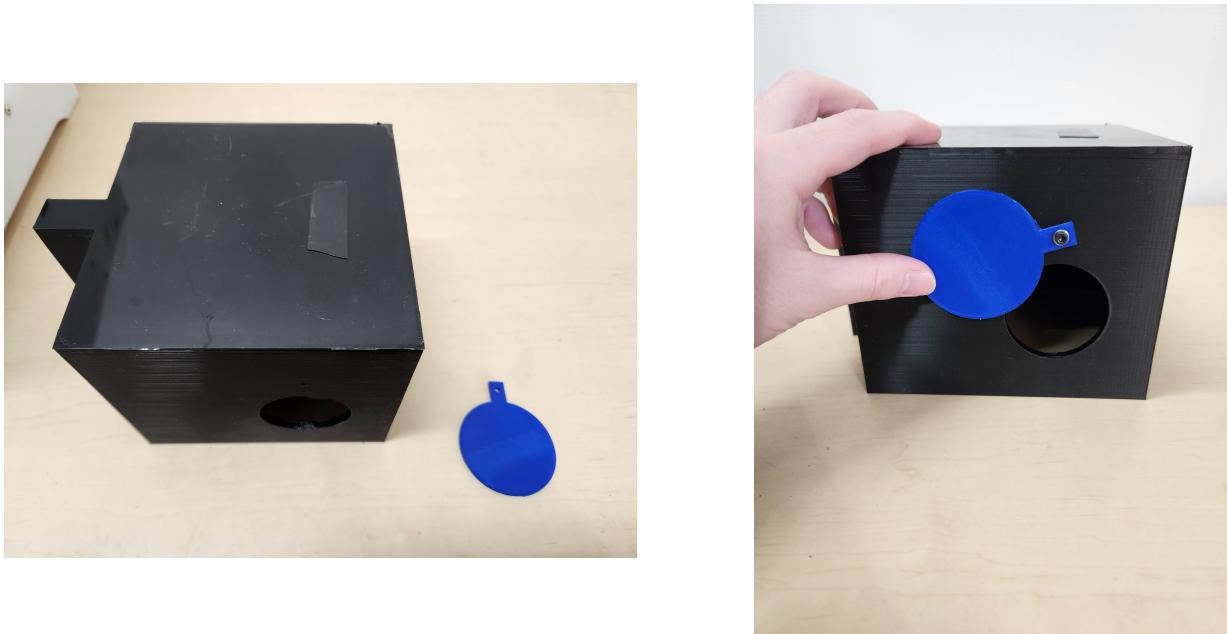


Figure 1: (left) `shielding_box.stl` and `window.stl`, (right) assembled product

2 power supply module

Parts List

- `power_supply_module_box.stl`
- `power_supply_module_box_lid.stl`
- Toggle switch (S-21A, NKK switches)
- High-voltage transformer² (UFO-6K-001-P100, UNION ELECTRIC)
- Power cable
- Two banana plugs

1. Solder banana plugs to the output side of the transformer (Fig. 2 left).

¹If the filament used to print "`shielding_box.stl`" is not black, there may be insufficient light shielding, making observation difficult. In such cases, it is recommended to apply black paint on the inside.

²The high-voltage transformer is designed for an input voltage of AC 50/60Hz, ranging from 0-100 V, and it amplifies this voltage by a factor of 60.

2. Solder the high-voltage transformer, toggle switch, and power cable as shown in the photo (Fig. 2 center).
3. Attach the toggle switch to the `power_supply_module_box.stl`, insert the transformer, and secure it with screws (Fig. 3). While screws are not necessary, securing them with screws and nuts is advisable to prevent misalignment. Depending on the print quality, installation may be slightly challenging.
4. Finally, cover it with the lid to complete the assembly.

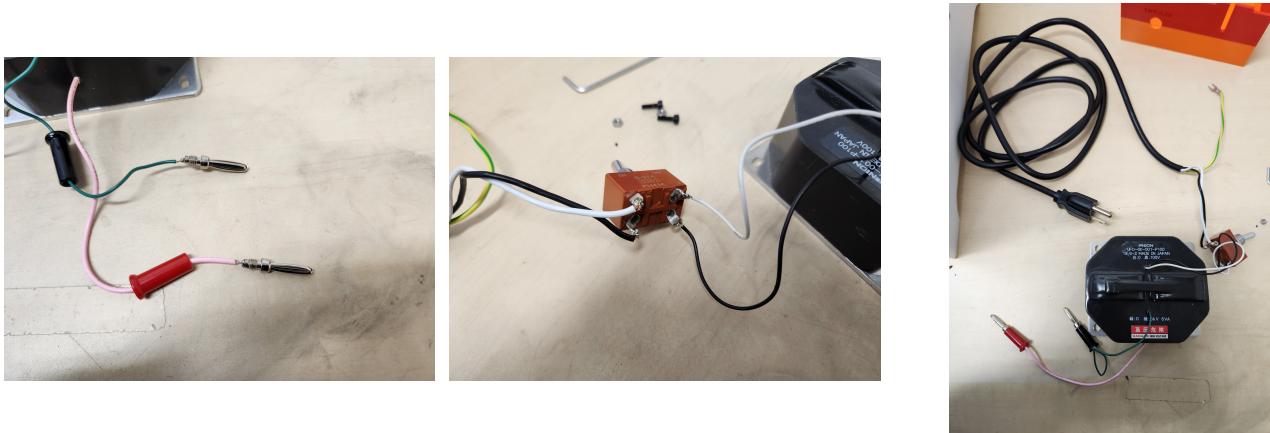


Figure 2: (left) soldering banana plugs, (center) soldering toggle switch (right) the finished product after soldering



Figure 3: (left) attach the toggle switch to the `power_supply_module_box.stl`, (center) insert the transformer (right) assembled product

3 ring-type electrode module

Electrode section

- `ring_electrode.stl`
- `endcap.stl`
- `electrode_holder.stl`
- Conductive paint (SKU-0216, BARE CONDUCTIVE)
- M3 Low-profile screw (4 mm)

- Crimp terminal
- Jumper wire
- M4 Screw (10 mm). Recommended hex socket screw

LED section

- `LED_holder.stl`
- LED
- Breadboard
- Jumper wire
- 9 V battery
- Toggle switch (448-0753, RS PRO)
- Battery Strap (489-021, RS PRO)
- Resistor
- M4 Screw (10 mm). Recommended hex socket screw

Web camera section

- `camera_jig.stl`
- Web camera (USB130W01MT-MF40-J)
- 1/4-inch screw

Main body section

- `ring_trap_box.stl`
- `ring_trap_box_lid.stl`
- Two banana sockets (23.3020-21, Staubli)
- Two 10 MΩ resistors (HB110MFZRE, TE Connectivity)
- Crimp terminal

3.1 Ring electrode

1. Apply conductive paint to `ring_electrode.stl` and `endcap.stl`, and let it dry (Fig. 4).
 - Consider multiple coats if adhesion is poor.
 - Note: Conductive paint is not suitable for long-term storage; proper storage is crucial to prevent drying. Adding a small amount of water can revive it, but the quality may be compromised.
2. Prepare jumper wires with crimp terminals on both ends.
3. Connect one end to the electrode using a low-profile screw (Fig. 4).
 - Be mindful of wire orientation.
4. Attach the electrode to `electrode_holder.stl`, aligning as shown Fig. 5.
5. Secure with screws
 - Not all holes need to be used.
 - Hex screws are recommended because the holes haven't been fully tapped, so the screw is tight.

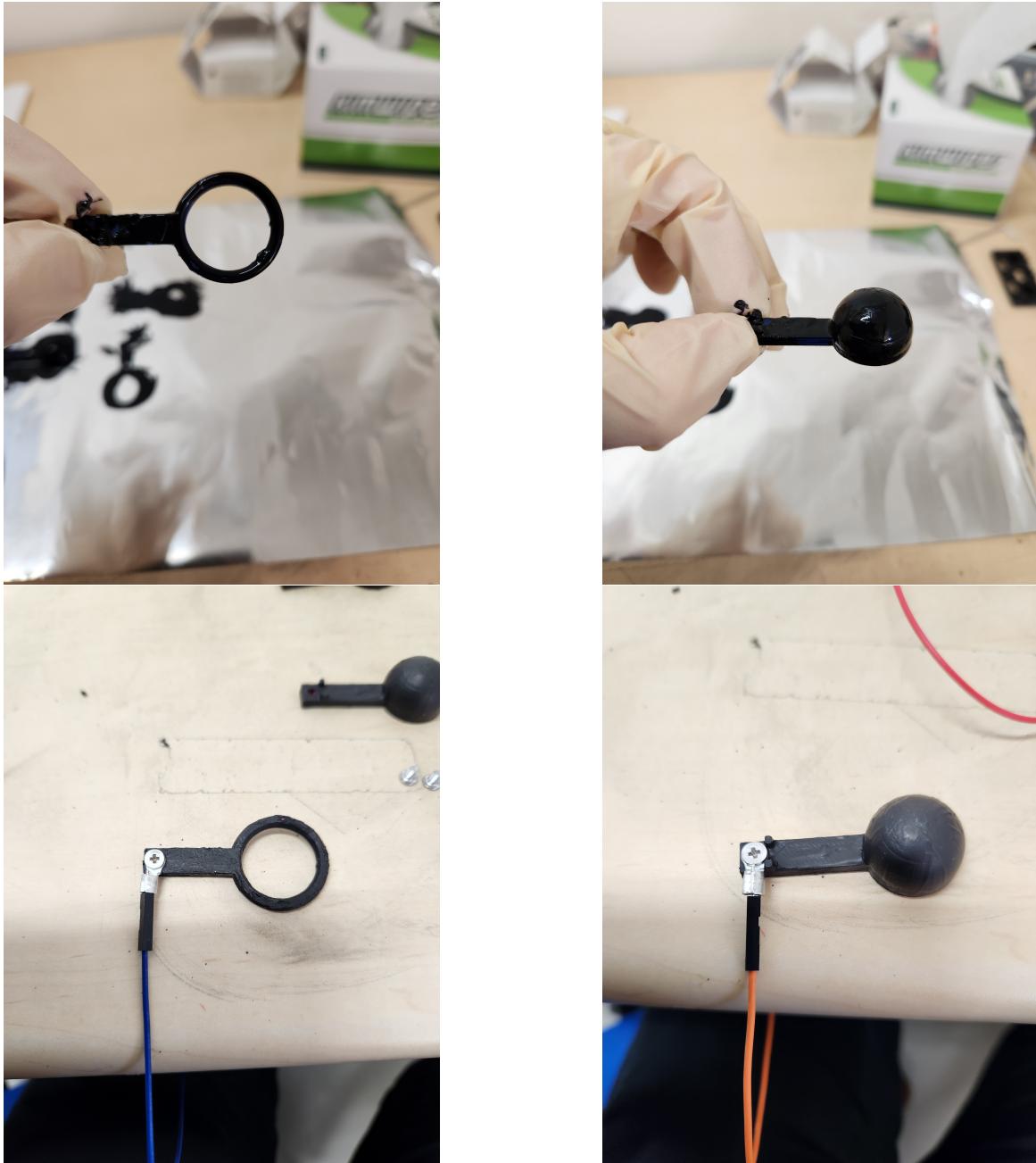


Figure 4: (left) ring electrode, (right) endcap

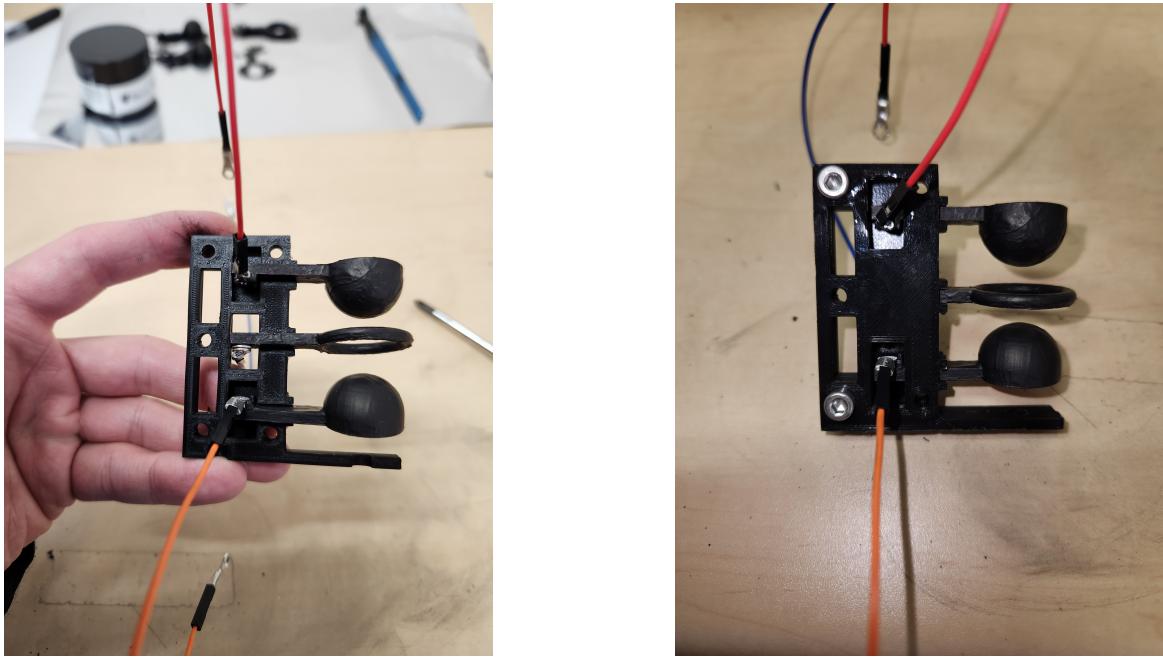


Figure 5: (left) attach the electrode to `electrode_holder.stl`, (right) securing with screws

3.2 LED circuit

If you can create a circuit that illuminates an LED, any circuit is acceptable. A brighter LED enhances visibility, and a blue-toned color is recommended. However, please note that we use the toggle switch (448-0753, RS PRO), and there is a side opening for its installation. Additionally, for the jumper wire connecting to the LED, having a longer length makes installation easier.

Figure 6 represents an example of an actual circuit in use.

Note: `LED_holder.stl` will be attached after installing the cover, as explained later.

3.3 Web camera and Main body

1. Attach the banana sockets to `ring_trap_box.stl` (Fig. 7 left). The limited space may make installation challenging, so use tools like needle-nose pliers to assist in securing.
2. For safety, install a $10\text{ M}\Omega$ resistor between the high-voltage transformer and the electrodes (Fig. 7 left). Attach crimp terminals to both ends of the resistor, securing one end to the banana socket with a screw. While this setup is generally sufficient, be aware of potential metal fatigue leading to foot breakage. Improvements may be considered in the future.
3. Place the previously mentioned LED circuit inside the box and attach the toggle switch to the side hole (Fig. 7 center).
4. Cover with `ring_trap_box_lid.stl`. Ensure the LED and electrode terminals protrude through the holes in the lid (Fig. 7 right).
5. Install the web camera fixture as shown in the figure and set it on the lid (Fig. 8 top panel).
6. Fix the LED in place with tape, secure it in the holder, and fasten with screws, preferably hex screws as recommended (because the holes haven't been fully tapped, so the screw is tight).
7. Insert the completed electrode and LED stand into the slots. Since they are intentionally made snug for stability, firm pressure is required for insertion (Fig. 8 middle panel).

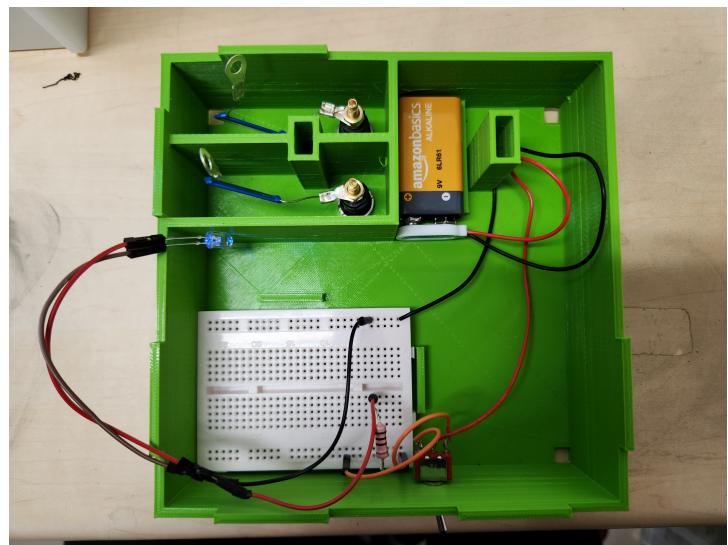
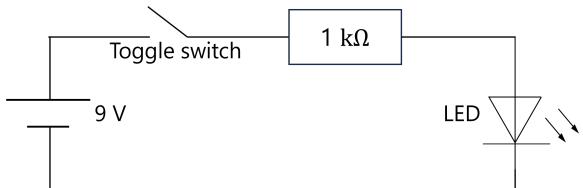


Figure 6: An example of LED circuit.

8. Connect the electrodes (ring electrode and two endcaps) to the terminals of resistors. The assembly is complete (Fig. 8 bottom panel).



Figure 7: (left) attach the banana sockets to `ring_trap_box.stl`, (center) attach the toggle switch to the side hole, (right) extend the terminals of the LED and electrode through the holes in the lid

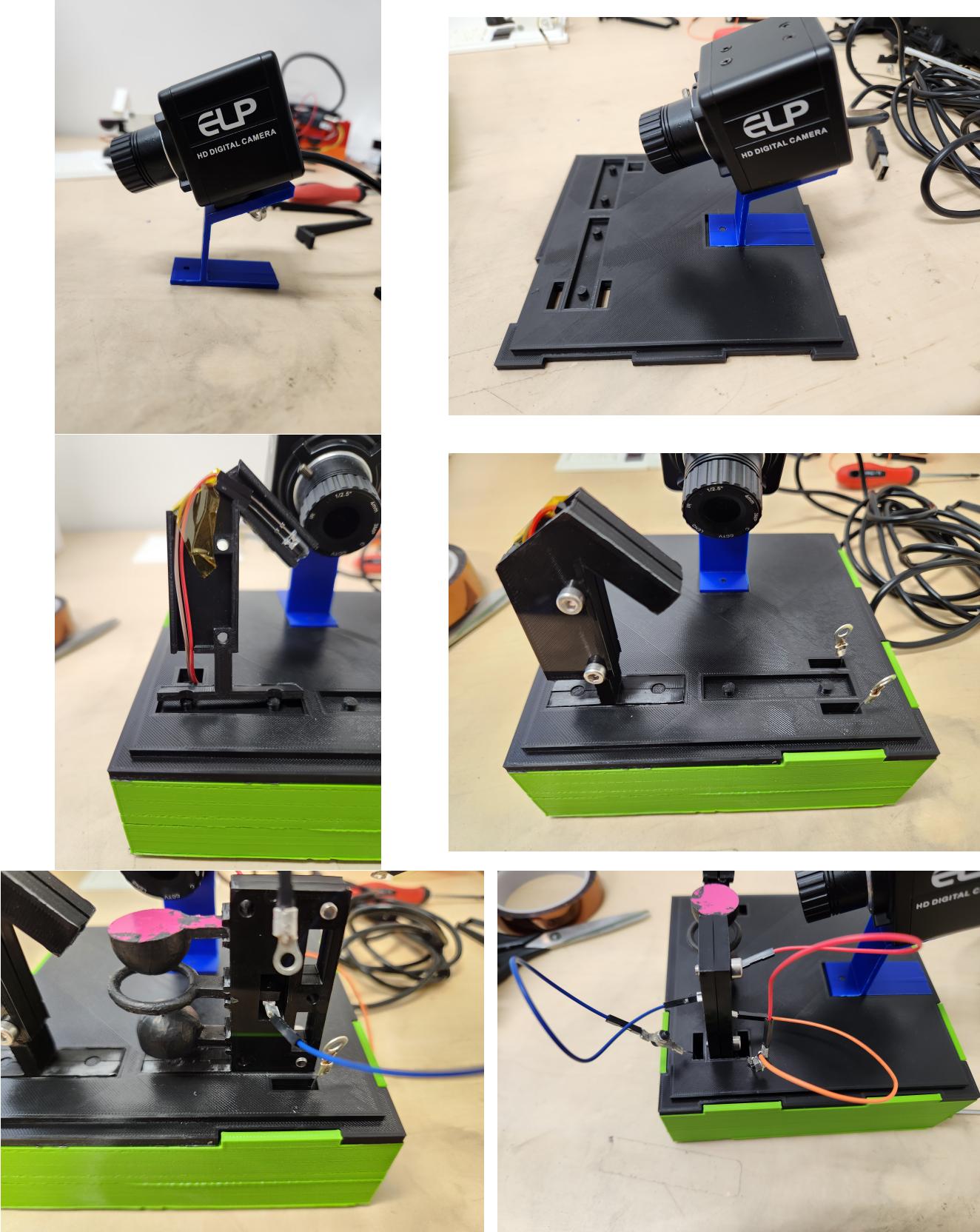


Figure 8: (top panel) web camera and `camera_jig.stl`, (middle panel) LED holder, (bottom panel) connect the electrodes to the terminals of resistors