Supplementary Materials:
Photobleacher Assembly Instructions

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I - SAFETY CONSIDERATIONS

Before beginning the assembly, please take the following safety precautions.

1. **Make sure the device is unplugged and switched off before performing any maintenance or connection checks.** The device is designed to operate at a constant +24VDC, which is a safe level for humans. However, please use caution when making connections with the power input module and any AC voltage. Any short could potentially cause damage to the components.
2. **DO NOT look directly at the LEDs when they're on**. The LEDs used in this are extremely bright. Use appropriate eyewear protection or use a physical shield to block the light when using and testing the system.
3. Maintain standard electronics and workshop safety standards. This includes wearing eye protection, an emergency plan, and any other safety rules your space requires.

II - PRE-ASSEMBLY NOTES

Notes on Wiring and Cable Management:

For all the electronic connections to be made, the wires of the components may need to be extended. This is especially true for the fans and the front panel on/off switch. We offer several solutions for this in these instructions depending on soldering experience and soldering iron access. If you have access to a soldering iron, but are inexperienced with soldering, we recommend looking up tutorials on “lineman splice”, a technique to connect 2 wires together. If assembling the LED PCBs yourself, a tutorial on how to solder through-hole and surface mount components may be helpful.

With the many electrical connections within the device enclosure, it’s very easy for the wires to become tangled and messy. We recommend using various forms of cable management items, such as zip-ties, adhesive backed zip-tie holders, and Velcro straps. We’ve also added gaps in the bulkhead panel separating the bleaching chamber from the power supply portion. These gaps will allow you to bundle up wires and feed them through, making the inside much cleaner. Proper cable management and wire bundling will make it easier to fix any issues that may arise.

Finally, we have color coded the wires in these instructions. We’ve followed standard industry practices and coded the wires as: Red for +DC voltage, Black for -DC voltage, Brown for Live (Hot) AC signal, Blue for Neutral AC signal, and Green for Ground. These color codes are helpful for following signal lines and debugging. Also note that the -DC voltage is connected to the protective earth/chassis ground (denoted as GND) of the AC power input and may be used interchangeably. Earth Ground is connected to the chassis via the mounting screw on the DC power supply.

Note on Bulkhead Panel Placement:

The bulkhead panel, which is the metal sheet that separates the power supply and power input section from the LEDs and fans, is a tight fit within the enclosure. When assembling this for the first time, we found the panel was most easily installed before mounting the fans on the enclosure. **Make sure to install the bulkhead before the final mounting of the fans, otherwise you may not be able to get the bulkhead in place.** Specifically, the large fans in the middle, when mounted, will block the panel. If desired, you can mount all the other fans, then install and secure the panel. After the panel is installed, you can mount the middle fans. When installing the panel, you may need to rotate it diagonally for it to fit inside the enclosure.

Custom-made Materials:

Material	File Names	Notes
Chassis/Enclosure	HEI-2400 RevA Photobleacher Enclosure Main Assembly	We used the third-party vendor, Protocase (https://www.protocase.com). A white powder-coated steel sheet was selected.
LED PCB	100mm_LED_Panel (KiCad Project File)	We used the third-party vendor, PCBWay (https://www.pcbway.com).
Glass Sample Stage	GlassShelf.pdf	A 1/4″-thick borosilicate glass was manually trimmed using a glass cutter and drill. See Chapter X for the details.
Spill Protection Bezel	Spill_Tray_bezel.stl	3D printed with a FDM printer, Prusa XL, using PETG. If a large-format 3D printer is not available, find a third-party 3D printing service.

III - TOOLS LIST

For a detailed list of parts, please refer to the Bill of Materials (BOM) included in the Supplementary Materials.

In addition to the BOM, some tools are required to complete the assembly. Other tools are not necessary but can be very helpful in debugging. A table for each set of tools is shown below.

Table 1: Required Tools

Name of Tool
Philips-Head Screwdriver(s)
Allan Key Set (Metric)
Socket Wrench and/or Pliers
Crimping Tool
Wire Cutters and/or Wire Strippers

Table 2: Optional Tools

Name of Tool
Multimeter
Soldering Iron
Hot-Air Rework Station
Solder Paste
Electronics Tweezers
Putty Knife
Variable Benchtop DC Power Supply

Table 3: Consumables

Name of Consumable
Double-sided VHB tape
16 AWG Stranded Wire (Red, Black, Green, Brown, Blue)
18-24 AWG Stranded Wire (Red & Black
SuperGlue
Solder Paste

IV – LED PCB Assembly

We recommend having your PCB vendor do the assembly of the LED PCBs. You will need to provide all part names and numbers, which can be found in the PCB BOM. If you've received the boards pre-assembled, you can skip to Part 2 of this section, Testing & Verification. We ordered our boards from PCBWay and assembled them ourselves.

If you decide to assemble the PCBs yourself, you will need both Hot-Air Rework and solder paste. We also recommend ordering a Solder Stencil along with the PCBs. If available, a reflow oven is ideal for attaching the surface mount components to the front (LED) side of the PCB.

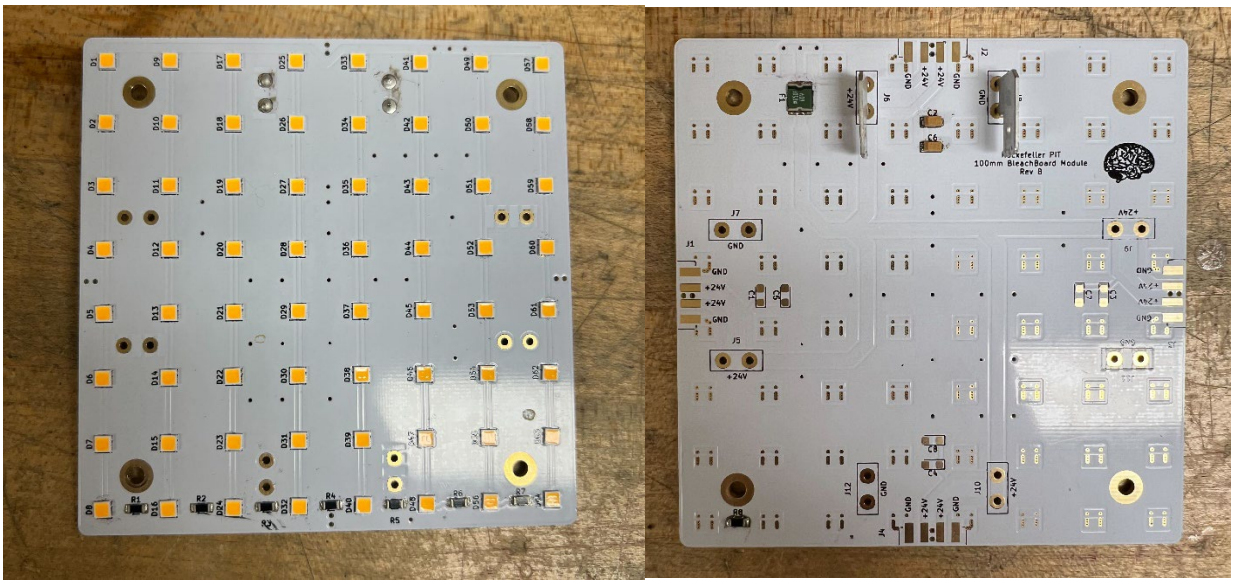

Figure 1: A fully assembled LED PCB board, showing top (left), and bottom (right). The top consists of the LEDs while the bottom consists of the fuse, capacitors, and connectors.

Part 1 – PCB Assembly

1. Start with the side with the LED footprints. Use the solder stencil to align the holes in the stencil with the footprints. Use a putty knife to spread the solder paste onto the board and onto the footprints through the holes. Remove the stencil and you should see each footprint filled with solder paste.
2. Carefully place the LEDs on the footprints (marked D1-D64 on the board). The corner with the white triangle tab indicates the cathode of the LED and should be aligned with the bottom-left corner, next the “D” mark, and towards the resistor footprints. See Figure 2 for reference.

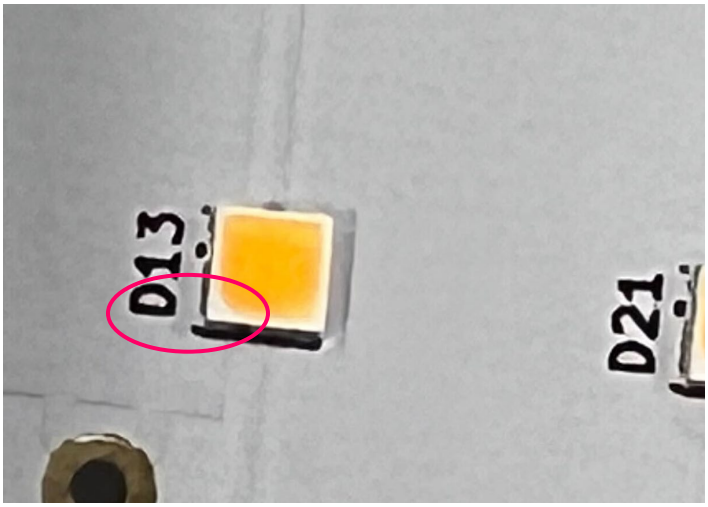

Figure 2: The polarity of the LEDs on the board. Note the white tab, which marks the cathode.

3. Place the resistors on the resistor footprints (marked R1-R7 on the board). Polarity for the resistors does not matter; just align the resistors with the footprint.
4. Once all components are placed, use either a reflow oven (if available), or a hot air rework (heat gun) set to ~500-600F. You can also use a standard heat gun but be aware of the high air flow moving the components.
5. Turn the board over and apply paste to the footprints (either with or without a solder stencil).
6. Place the remaining resistor on the R8 footprint.
7. Place the fuse chip on the F1 footprint.

8. Place the capacitors on the footprints marked C1-C8. The capacitors used in this assembly are polarized; make sure the line on the backage is connected to the +24VDC line.
9. Place the inter-board connectors onto the footprints marked J1-J4. Make sure the pins are aligned with the tab and that the pegs on the connectors are through the corresponding holes on the board. You can omit inter-board connectors where no connections will be made.
10. Repeat step 4 for this side of the board. **Note**: You may want to use a lower heat setting when reflowing the inter-board connectors, as too high a heat can cause the plastic to melt and the connection pins to become mis-aligned.
11. Let the board cool down after reflowing, then solder the tab connectors to the through holes marked J5-J12. You will only need to solder one set of tab connectors, and only to adjacent through holes (for example, J6 and J8 can be soldered in, and the left rest blank). The tab connectors should be sticking out of the bottom of the board and faced towards the edge of the board. See Figure 3 for reference.

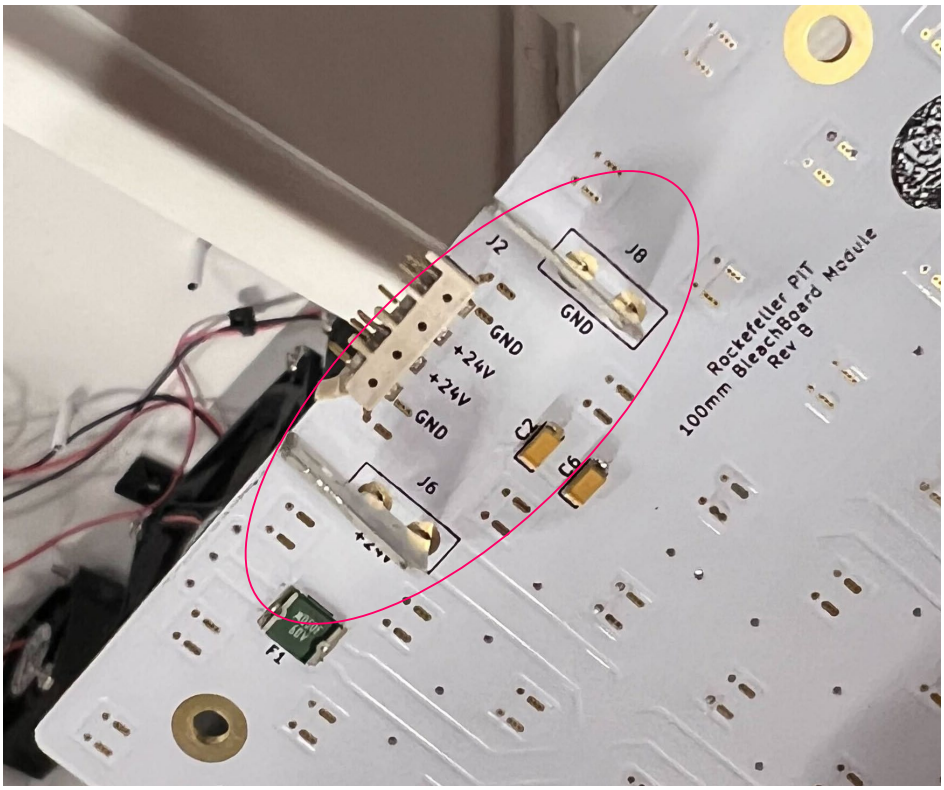

Figure 3: Orientation of the blade connectors. They should be pointed to the edge of the board.

Part 2 – Testing & Verification

The board should now be ready for testing. Use the following steps to ensure your boards are operational.

1. Prepare 2 wires and crimp one end with quick tab connectors, and the other end bare.
2. Connect the wires to the tab connectors on the board as shown in Figure 4. Note which one is the +24VDC line and which one is the negative line (marked GND on the board).

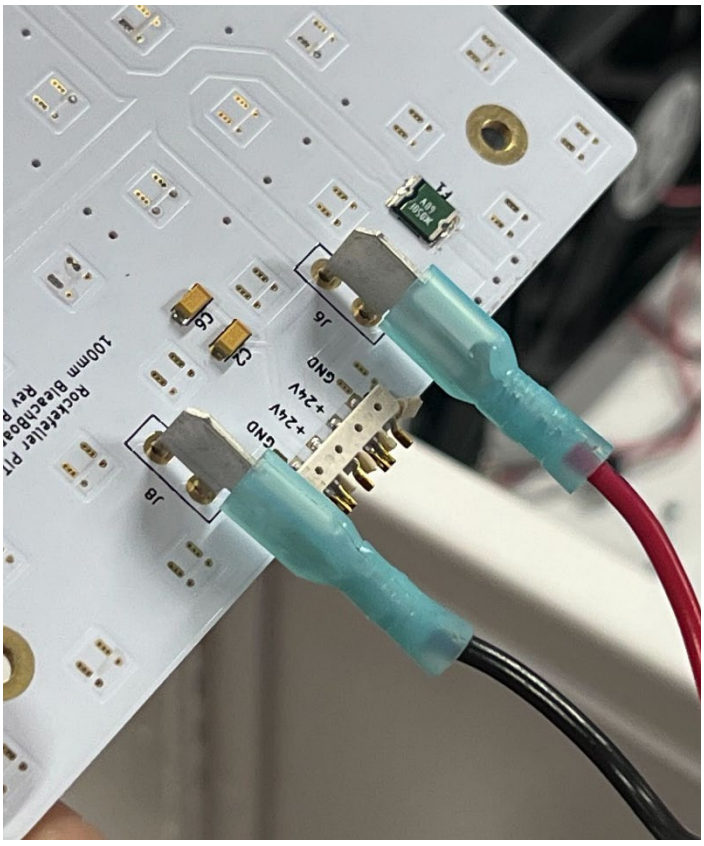

Figure 4: Attachment of wires to the power input blade connectors using quick-tab connectors.

3. Using a variable benchtop power supply, first turn on the supply and bring the voltage down to 0V. Connect the supply probes to the wires and double check that the polarity is correct. Then, slowly turn up the voltage and watch the current reading. **If the current spikes when the voltage is below 1V, there is likely a short.** The fuse mounted on the bottom of the board should protect the components from excessive current. Refer to the troubleshooting guide of this section.

If there are no current spikes, slowly increase the DC voltage to 24V and verify that all LEDs are on. They should turn on dimly around 15-17V and start increasing in brightness as you turn up the voltage. If you notice any LEDs not turning on, refer to the troubleshooting part below.

You can speed up the testing of the rest of the LED boards once you have 12 boards assembled. Connect them together with the inter-board connectors (as described in the LED panel Section later in this guide). Connect up to 6 boards together; any more and you may exceed the current limit on your power supply. You can then test the 6 LED panels at once and check for any LEDs that are off.

Part 3 - LED PCB Troubleshooting

A - If no LEDs turn on:

1. Check the fuse on the bottom of the board. Use a multimeter and probe each side of the fuse to verify the connection. If there is no connection, then a current spike likely destroyed it, or it is not soldered on properly. Remove the fuse and check the part of the board for damage. You may also want to probe between the +24VDC and GND lines to see if there is still a short. If there is, remove all the capacitors from the back and probe again. If there is still a short, remove the inter-board connectors and probe again. If you are still getting a short, it is likely that the board is damaged, and a new one must be assembled.
2. If there are no shorts and the fuse is still intact, check the LEDs at the top of each LED column (the bottom of the board is located where the resistors are). The LED may be misaligned or orientated incorrectly or may be not connected altogether. Make sure the cathode marker is in the right place (next to the “D” mark) and reflow the LED again. If your multimeter has a diode check setting, you can verify the LED is still working by probing the anode with the positive probe and the cathode with the negative probe. The LED should light up if properly connected. Test again with the benchtop power supply and verify.

B - If some columns of LEDs turn on while others do not:

1. The issue is likely an LED that is not connected to the pad or in the wrong orientation, which interrupts the path for the electrical current. With a multimeter, use the diode function to test each LED in the column. Using fine-tipped probes, touch the small, exposed pad on the anode of the top LED to the anode of the next LED. You should see the LED light up and a voltage appear on the multimeter. Repeat this process down the column until you see the LED that doesn't light up when probed. Reflow the offending LED and continue the process down the column until all LEDs are verified.

C - If individual LEDs don't turn on:

1. The issue is likely a short on the pad of the LED that's off. This can be caused by too much solder on the pad or misalignment of the LED. Remove the LED and inspect the bottom of it. If there's any solder bridging the anode and cathode terminals, reflow the LED and lightly scrape the excess solder away with a pair of tweezers (if you have extra LEDs, you can simply replace the LED with a new one). Next, check the LED footprint pad for extra solder and scrape away any that you see while reflowing. Test the pads with a multimeter to ensure there's no short. Replace the LED and reflow with the hot-air rework. Repeat for any other LEDs that are off.

V - Power Input Assembly

Table 4: Components Required for Section V

Quantity	Description	Manufacturer Part Number	Notes
1	AC/DC Converter 24V 200W	CUS200M-24	Main DC Power Supply
1	PWR ENT MOD RCPT IEC320-C14 PNL	KM01.1205.11	AC Power input module, to be inserted into the back
1	Fuse Drawer for Power input module: F'GRIP 1PL	4301.1405	Insert fuse drawer, then insert fuse into Power Input Module
1	FUSE GLASS 2.5A 125VAC 5X20MM	7010.345	Fuse for Power Input Module
1	100-Amp DualBus	2702	Terminal Bus Block for DC voltage signals
1	RELAY GEN PURPOSE DPDT 10A 120V	LY2F-AC110/120	Power Output Relay
1	CONN RCPT HSG 5POS 3.96MM	VHR-5N	AC Power input connector
1	CONN RCPT HSG 6POS 3.96MM	VHR-6N	DC Power Output Connector
3	CONN SOCKET 18-22AWG CRIMP TIN	SVH-21T-P1.1	Crimp Contact for AC Input Connector
6	CONN SOCKET 16-20AWG CRIMP TIN	SVH-41T-P1.1	Crimp Contact for DC Output Connector
3	CONN QC RCPT 14-16AWG 0.187	190030056	Blue Quick-Connect: Female
2	CONN QC RCPT 18-22AWG 0.187	190030011	Red Quick-Connect: Female
2	CONN RING CIRC 14-16AWG #8 CRIMP	0190540110	Ring Connectors for Terminal Block Bus

For this section, use the wiring diagram for reference. The wiring diagram is included in the supplementary materials section

1. Place the Fuse in the fuse drawer as shown in Figure 5. Insert the drawer into the power input module.

Figure 5: Glass Fuse inserted into the Fuse Drawer

2. Place the Power Input Module into the square slot in the back so the ON/OFF switch and power plug socket is facing the outside shown in Figure 6. Note: the fit might be tight, you will need to squeeze the tabs on the power input module inward to properly install. You also may need to file down the opening with a metal file.

Figure 6: AC Power input module installed in the back panel of the enclosure.

3. Using the mounting holes in the back, screw in the DC Power Supply. The Terminal Bus Block should be attached between the Power Supply and the Relay mounting holes with double-sided VHB tape. Refer to Figure 7 for placement references. Note: If desired, you can drill mounting holes in the enclosure to align with the mounting holes on the Terminal Bus Block.

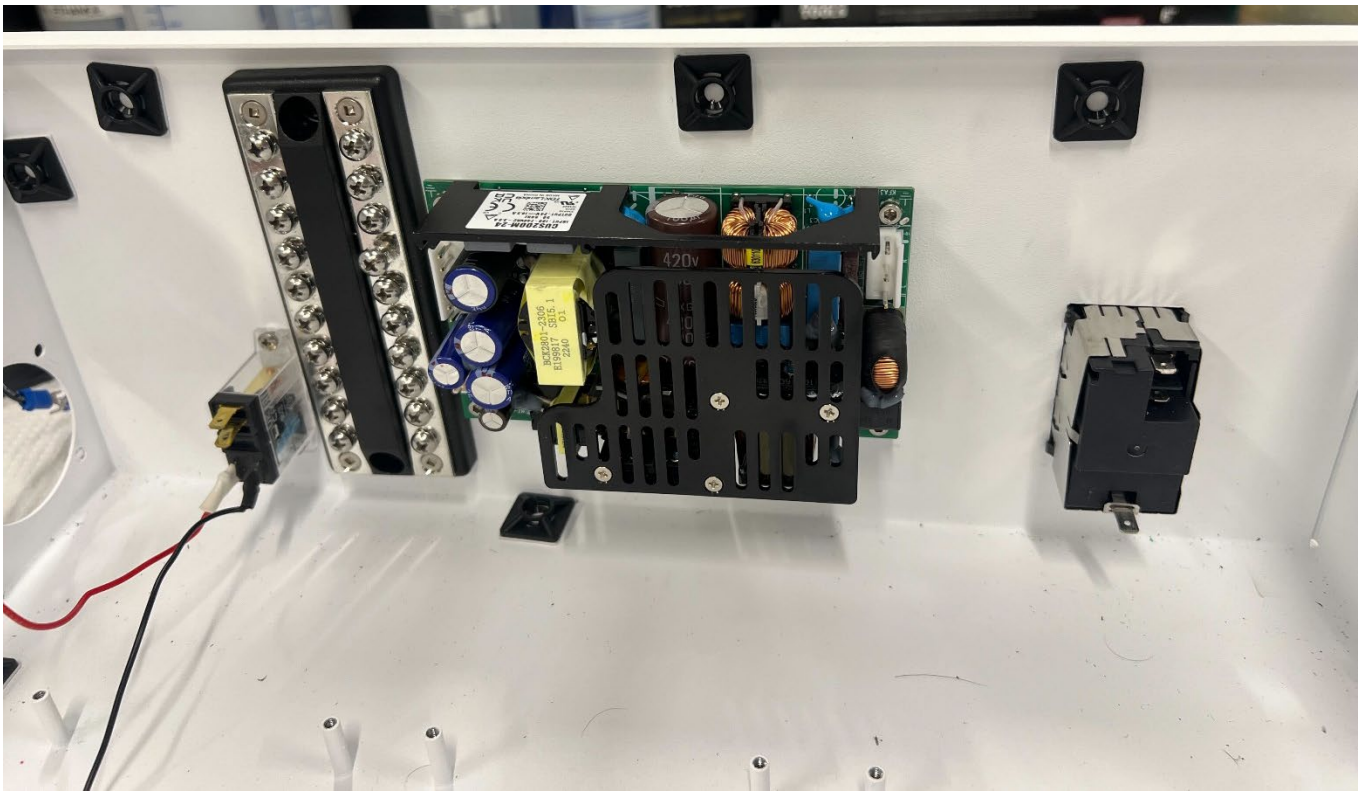

Figure 7: Mounting locations for AC Power Input Module, DC Power Supply, Terminal Bus Block, and Relay

4. Prepare 3 wires of 3 colors: Blue, Brown, and Green, of at least 18AWG. One end of each wire should be crimped with quick tab connections, while the other end should be crimped with SVH-21T-P1.1 crimps and placed into the mating connector (part # VHR-5N) for the AC/DC power supply header. The wire colors are coded as such: Brown – Hot; Blue – Neutral; Green- Ground. Connect the quick-tab ends onto the Power Input Module (refer to the labels on the module for each connection). Then plug in the connector to the header on the AC/DC power supply. The connection is shown in Figure 8.

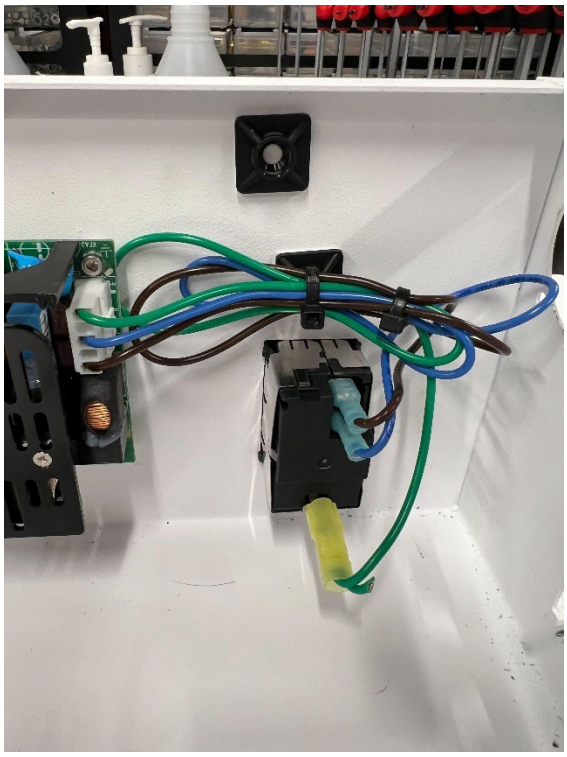

Figure 8: Electrical Connection from the AC Power Input Module to the input of the DC Power Supply

5. Prepare 2 wires: 1 red and 1 black (the red wire should be at least the length of the back of the chassis plus the side of the chassis; the black wire should be cut short). Solder the wires onto the 2 vertical tabs on the relay (labeled pins 1 & 5; the connections are non-polar; you can use either tab for either wire. You may want to unmount the relay to make the soldering easier). Crimp the other end of the black wire with a ring terminal and screw into the terminal block on the negative DC side. See Figure 9 for reference
6. Prepare 4 wires: 3 red and 1 black. One Red should be long, while the rest should be cut short. The long red, 1 short red, and 1 black should be crimped with SVH-41T-P1.1 crimps and placed into the mating connector for the DC output of the AC/DC power supply (part # VHR-6N). The other end of the black wire should be crimped with a ring terminal and screwed into the negative side of the terminal bus. The other end of the short red wire should be crimped with a quick connect and plugged into one of the horizontal tabs on the relay. The last short red wire should have one end crimped with a ring connector, and the other with a quick connect tab. Plug the quick connect tab end onto the other tab on the relay next to the previous tab connection, and screw in the ring connector side to the positive side of the terminal bus. See Figure 10 for reference.

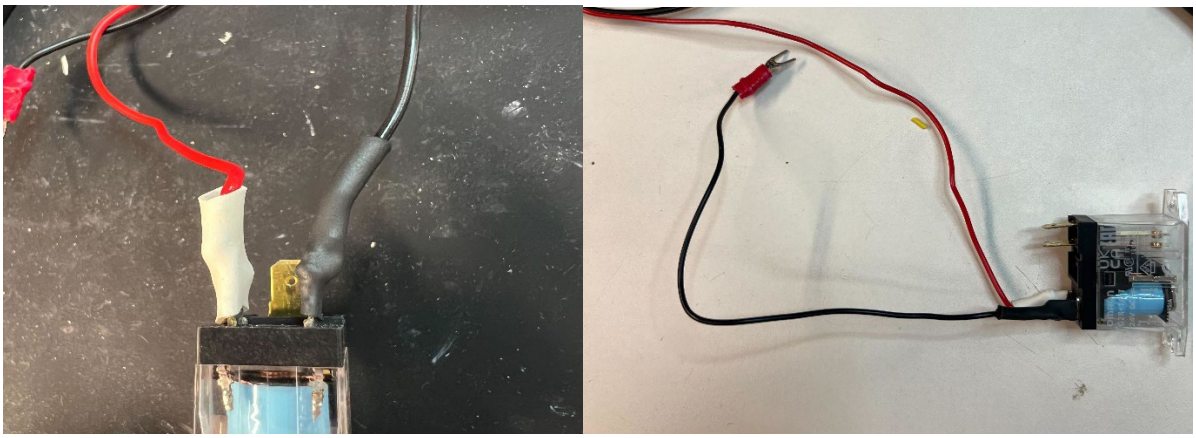

Figure 9: Soldered connections to the Relay. The pins are non-polar can can be switched

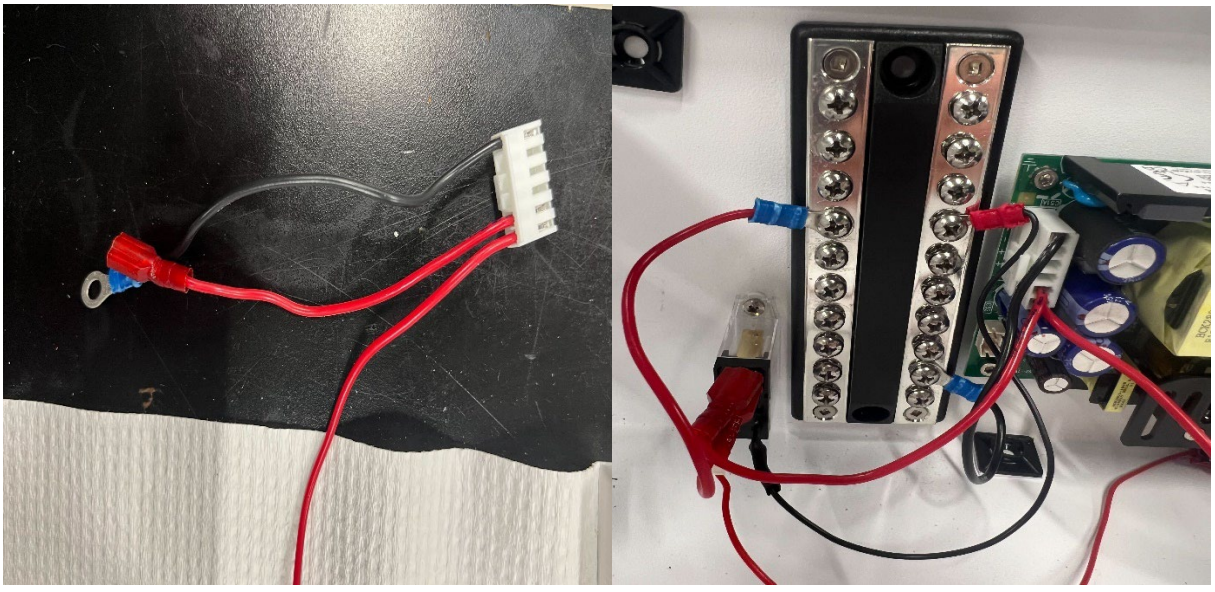

Figure 10: DC output connector (left) and connections for DC Power supply and the Relay to the Terminal Bus Block (right)

VI - Fan Assembly and Bulkhead Panel Installation

Table 5: Components Required for Section VI

Quantity	Description	Manufacturer Part Number	Notes
4	FAN AXIAL 92X20MM 24VDC WIRE	AFB0924HD	Main Stage Fans
2	FAN AXIAL 50X20MM 24VDC WIRE	AFB0524VHD	AC Power input module, to be inserted into the back
2	FILTR ASSB FAN GUARD 92MM 45PPI	4301.1405	Inlet Fan Cover
2	FAN FILTER GUARD ASSY 92MM ABS	LFG92	Outlet Fan Cover
2	FAN GUARD 50MM METAL	08248	PSU Fan Cover
24	M3 x 16 Philips Head Screw		Mounting Screws for fan
24	M3 Nut		Nuts for mounting screws
	Red Wire 18-24 AWG		
	Black Wire 18-24AWG		
2 - 6	CONN RING CIRC 14-16AWG #8 CRIMP	0190540110	Ring Connectors for Terminal Block Bus

Part 1 - Wiring:

1. Each fan has 2 wires: a red one for the positive DC voltage and a black one for the negative DC voltage. Each one must be connected to the terminal block on the appropriate side.
2. There are several wiring options based on available materials and expertise:
    a. Tie all the positive wires of the fans **on one side** together and tie all the negative wires together. You can solder them, extend them (either lineman splice or a connector) and crimp the other end so they only have 1 connection to the terminal block. This will reduce clutter and cable management but may make it more difficult to troubleshoot if a fan stops working.
    b. Extend the wires of each fan by soldering longer wires, following the red/black color scheme. Crimp the ends of the wires with ring terminals and screw into the appropriate sides of the terminal block.
    c. Use extension cable with a matching connector to the fan connector. This was not done in this assembly but can be done as an alternative. The other ends of the cable still must be crimped with ring connectors and screwed into the terminal block.
3. Once all the fans are connected to the terminal block, do any necessary cable management and be sure to align groups of wires with the slots at the bottom of the bulkhead.
4. Repeat the process for the fans on the other side.

Part 2 - Bulkhead Panel Installation:

**Note: The Bulkhead Panel can be tricky to place. Placing it before mounting the fans seemed to be the easiest option during our assembly.

1. Before inserting the panel, align any wires/cables to the gaps at the bottom of the panel.
2. Orient the Bulkhead so that the tabs are facing towards the back closer to the floor. Carefully lower it into the enclosure and align it with the mounting holes. See Figure 11 for reference. Note: You may have to turn the bulkhead diagonally to fit it into the enclosure.

3. Using the small M3 screws, attach the Bulkhead Panel to the Enclosure. See Figure 11 for reference. Make sure the wires are coming through the gaps at the bottom and are not being crushed by the bulkhead.

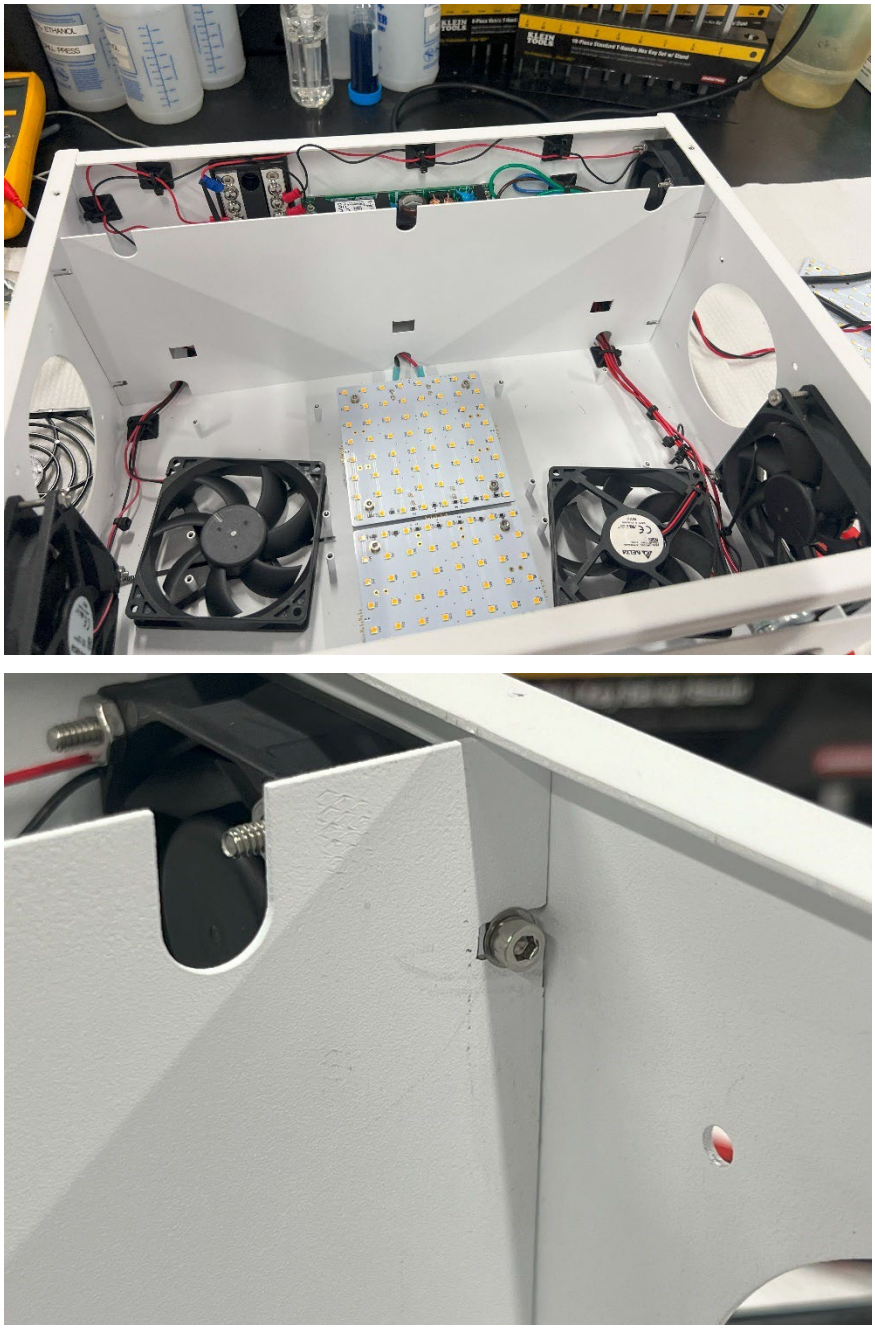

Figure 11: Fully installed bulkhead with wires through the bottom gaps (top). Location of proper mounting with M3 screws (bottom).

Part 3 – Fan Mounting:

1. Prepare the fan guards on the intake fan side (left side when looking at the enclosure door in this case). The foam filter should be placed in the outer fan guard as shown in Figure 12.

Figure 12: Filter being placed inside the fan snap cover. The snap tabs should be slightly above the foam filter

2. Screw in the Mounting Frame into the Fan Mounting holes as shown in Figure 13 using the long M3 screws.

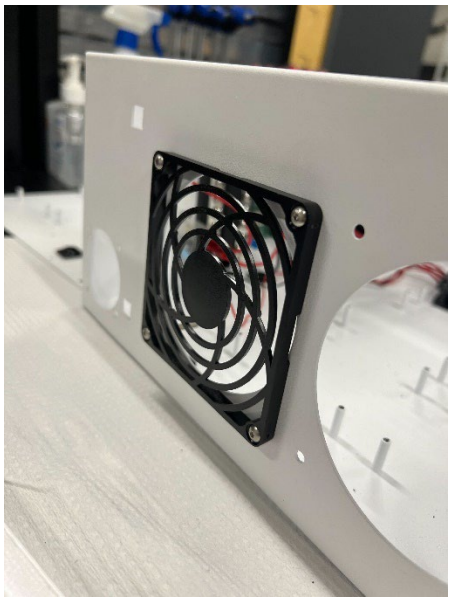

Figure 13: Mounting Frame attachment to the enclosure

3. Align the mounting holes on the fan with the screws coming through the mounting frame. Screw and tighten nuts on each screw. See Figure 14 for reference

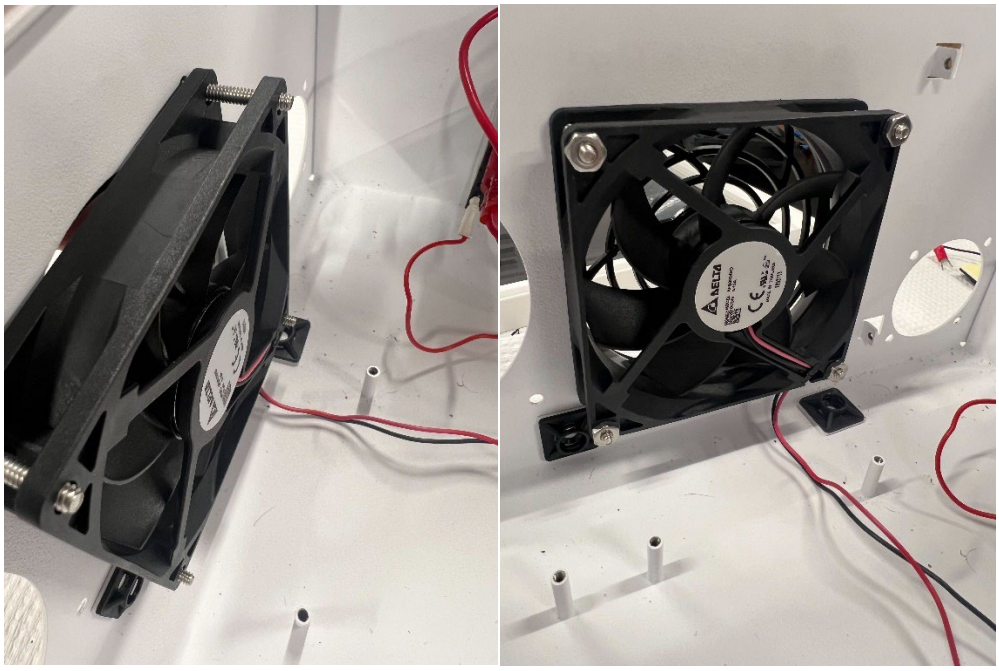

Figure 14: Alignment and mounting of fan with mounting screws (left) and with nuts tightened (right)

4. Repeat process for the other large fan.
5. For the small fan in the power supply section, you will only need the small metal fan guard attached to the outside. Mount the small fan. See Figure 15 for reference.

Figure 15: Metal mounting bracket for the small fan attachment to the enclosure (left) and small fan mounted to the inside (right)

6. For the outtake side, the mounting process is the same except there is no fan filter guard. The labels of the fan should be facing out. See Figure 16 for reference.

Figure 16: Fully mounted fans on outtake side (right) and intake side (left)

VII - Front Panel Switch and Reed Switch

Table 6: Components Required for Section VII

Quantity	Description	Manufacturer Part Number	Notes
1	SWITCH ROCKER SPST 16A 125V	KRE2ALA2RBB	Front Panel Rocker Switch
1	Magnet		Magnet on handle for reed switch
1	SENSOR REED SW SPST-NO W LEADS	59150-020	Front Panel Reed Switch
	SuperGlue		
	VHB tape		
	Red Wire 18-24 AWG		
	Black Wire 18-24AWG		

Part 1 – Front Panel and Reed Switch Wiring and Mounting:

1. Mount the front panel I/O switch to the small mounting hole on the front of the enclosure, to the right of the door. Squeeze the tabs on the side of the switch to insert.
2. Using the long red wire from the relay, crimp the other end with a quick connect and connect it to the middle tab of the front panel switch, as shown in Figure 17.

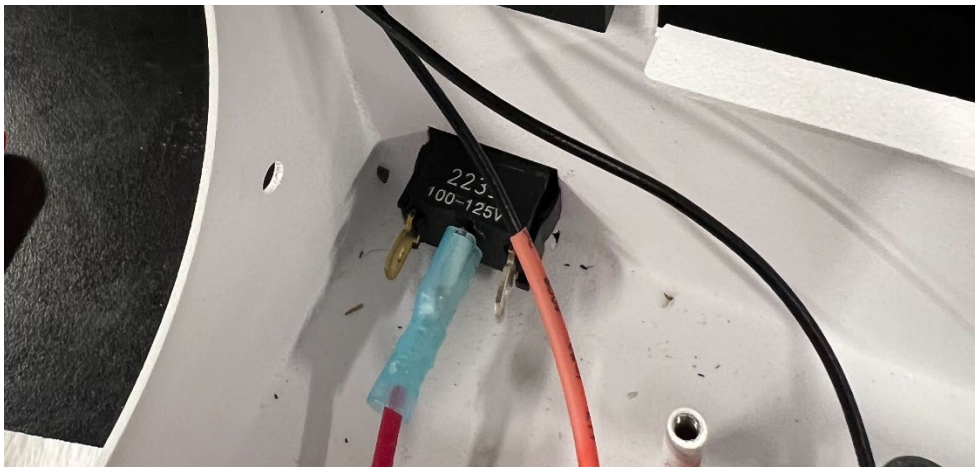

Figure 17: Connection to the middle tab of the rocker switch, which connects to the relay

3. Prepare a red wire with one end crimped with a quick connect tab. Leave the other bare. **Note**: If you'd like to test the reed switch positioning before powering the system, you can skip to step 6. Use a multimeter to check the connection once the magnet is glued
4. Prepare the reed switch. Strip one end of one of the wires (it doesn't matter which one) and connect it to the wire from step 3 (either by soldering it or attaching connectors). Connect the quick connect tab to the one remaining silver tab on the front panel switch.
5. Take the other wire of the reed switch and strip the end. Connect the end of that wire with the long red wire coming from the DC power supply.
6. Using double sided VHB tape, attach the reed switch to the inside of the front of the enclosure next to the door. **Note** you may need to adjust the positioning so that it activates when the magnet on the door latch comes close to it. Refer to Figure 18 for appropriate positioning.

Figure 17: Reed switch orientation and positioning. You may need to test the connectivity to find a more appropriate location depending on where you glue the magnet

7. Take a small metal magnet and super glue it to the latch of the door on the inside, as shown in Figure 18. You will need to let it sit depending on the working time of your chosen adhesive. **The positioning should be such that the reed switch should activate when the latch is fully closed (turned all the way clockwise)**.

Figure 18: Magnet superglued to the latch on the inside. Depending on the size of the magnet you may need to adjust the position

Part 2- First System Check:

At this point of the assembly, it may be helpful to check your connections and power on the system to see if the fans turn on. **Before powering on the system, use a multimeter to check for a short between the positive and negative sections of the terminal block**. If there is a short, refer to the Troubleshooting Guide for more info.

Open the front door of the enclosure and perform the following steps:

1. Turn on the back panel switch to the “I” position.
2. Turn on the front panel switch.
3. Close the door and turn the handle fully clockwise.

When the door closes, all the fans should turn on, with air flow entering the enclosure on one side and leaving on the other. If one or more of the fans don’t turn on, refer to the Troubleshooting Guide for more information.

VIII - LED Board Ceiling Assembly and Mounting

Table 7: Components Required for Section VIII & IX

Quantity	Description	Manufacturer Part Number	Notes
12	LED PCB boards		LED boards fully assembled
48	M3 x 10 Screws		Mounting Screws for Boards
4	CONN QC RCPT 14-16AWG 0.187	CONN QC RCPT 14-16AWG 0.187	Blue Quick-Connect: Female
4	CONN RING CIRC 14-16AWG #8 CRIMP	0190540110	Ring Connectors for Terminal Block Bus
	Red Wire 16-18AWG		+24VDC wire
	Black Wire 16-18AWG		-VDC (GND) wire
4	M3 Set Screw 10mm		Corner Floor Screws
8	M3 Standoffs 10mm		For Sample Stage Mounting

The next two sections assume that the PCB's have been prepared and verified. If doing your own PCB assembly, please refer to the PCB assembly section.

1. Prepare 6 LED boards for the ceiling mounting. If the boards have not been assembled and verified, do so at this time.
2. Take one board that has the tab connectors and mount it using M3 screws as shown in Figure 19. Orient the tabs so that they point towards the side edge of the ceiling panel (or towards the edge where there is a large gap between the edge and the mounting holes).

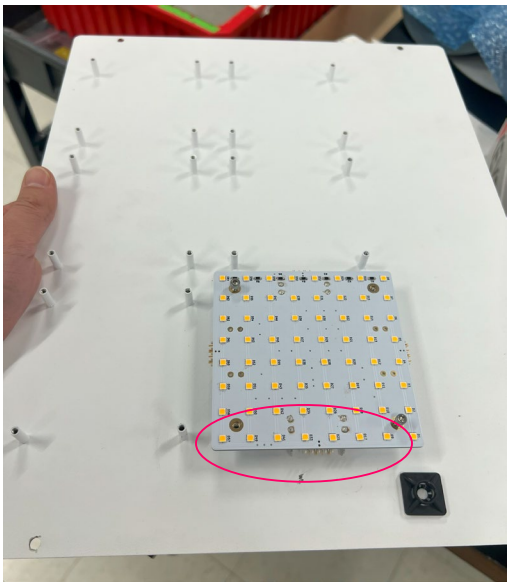

Figure 19: First board orientation and mounting. The pink circle shows the location of the blade connectors, which is the power input to the boards.

3. Prepare 2 wires: One red and one black. Crimp one end of each wire with quick connect tabs, and the other ends with a ring terminal.
4. Attach the quick connect tabs with the tabs on the PCB. **Check the polarity of the connection: Red should be on the +24V and Black should be on the GND.** You may need to unmount the board to double check. See Figure 20 for reference.

Figure 20: Power input connection to the LED boards. Note the polarity of the tabs.

5. Connect the other 5 LED boards. With the hermaphroditic connectors on all 4 edges of each PCB, you should theoretically be able to “drop” them in from above to connect to the adjacent boards. Align the boards with the mounting holes and screw them in with M3 screws. See Figures 21 & 22 for reference

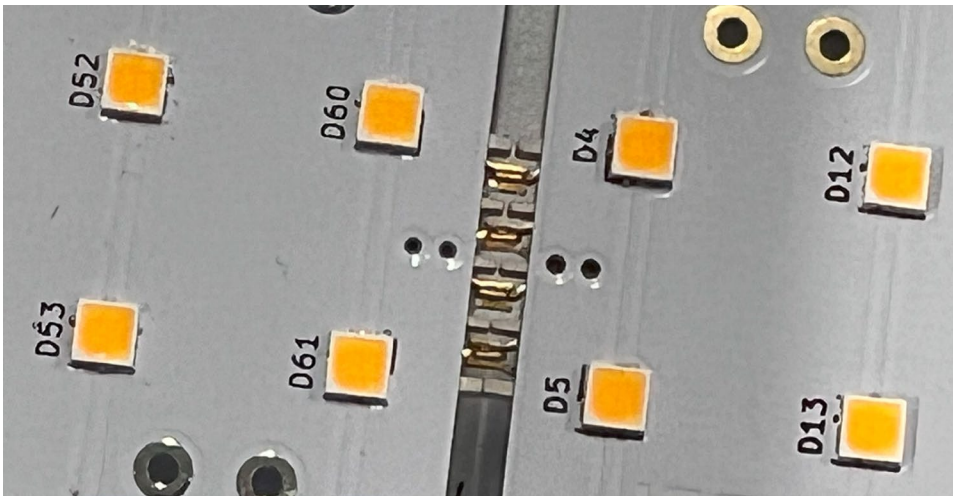

Figure 21: Two LED boards connected using the hermaphroditic interconnector

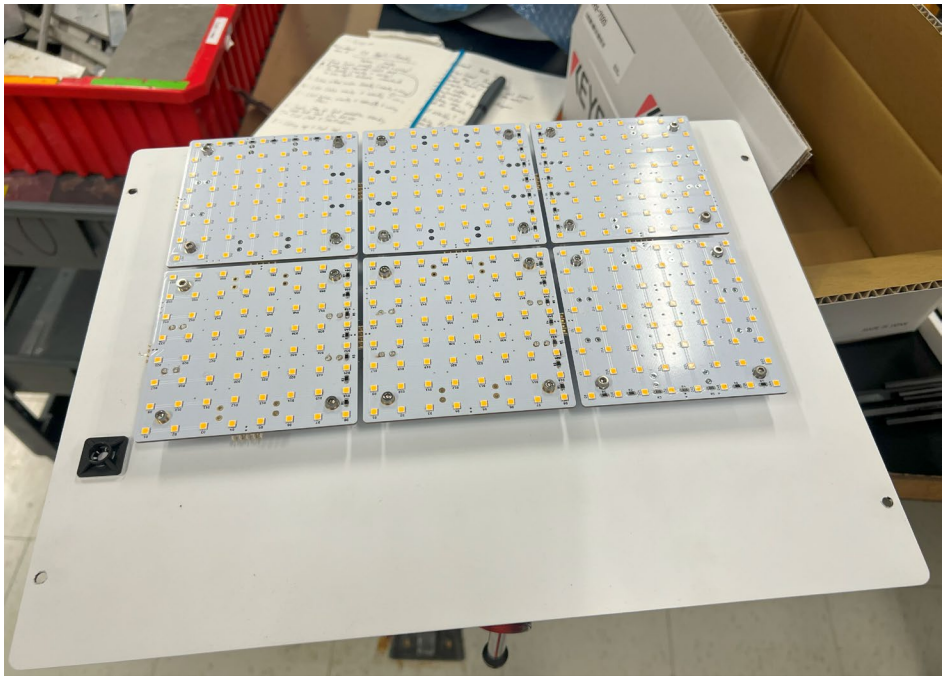

Figure 22: All 6 ceiling LED boards mounted

6. Take the wires connecting the PCBs to the terminal bus and carefully push them into the gap at the top of the Bulkhead Panel as shown in Figure 23.

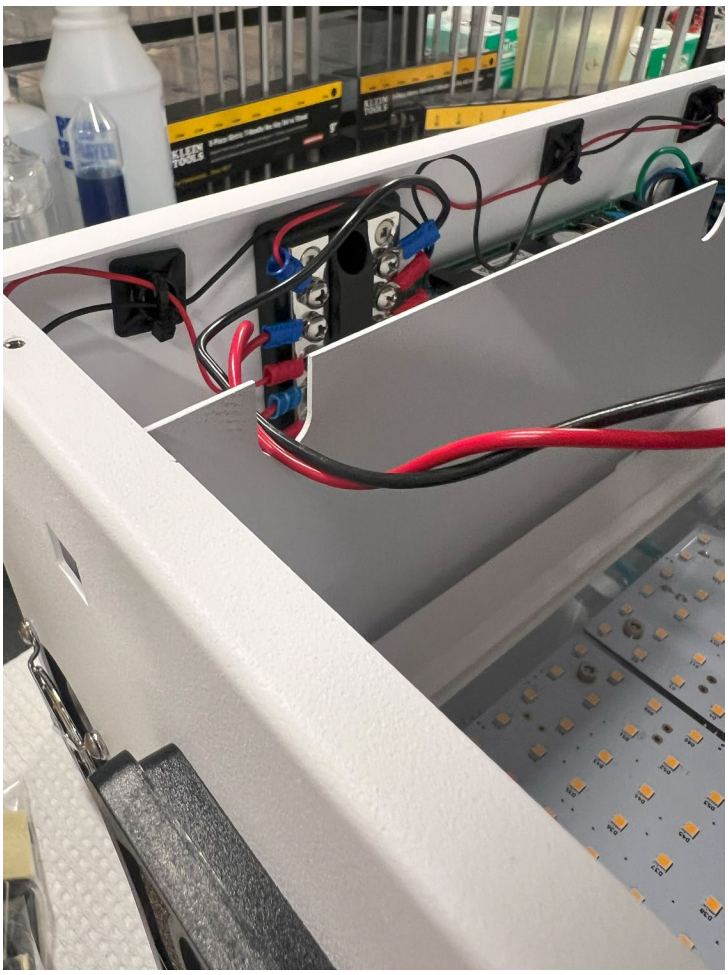

Figure 23: The power input wires from the ceiling LEDs inserted into the groove at the top of the bulkhead panel

IX - LED Board Floor Assembly and Mounting

1. Repeat Steps 3 and 4 of the previous section. This time, however, orient the PCB connector tabs so that they point towards the Bulkhead Panel, towards the back of the enclosure in the center. See Figure 24 for reference.

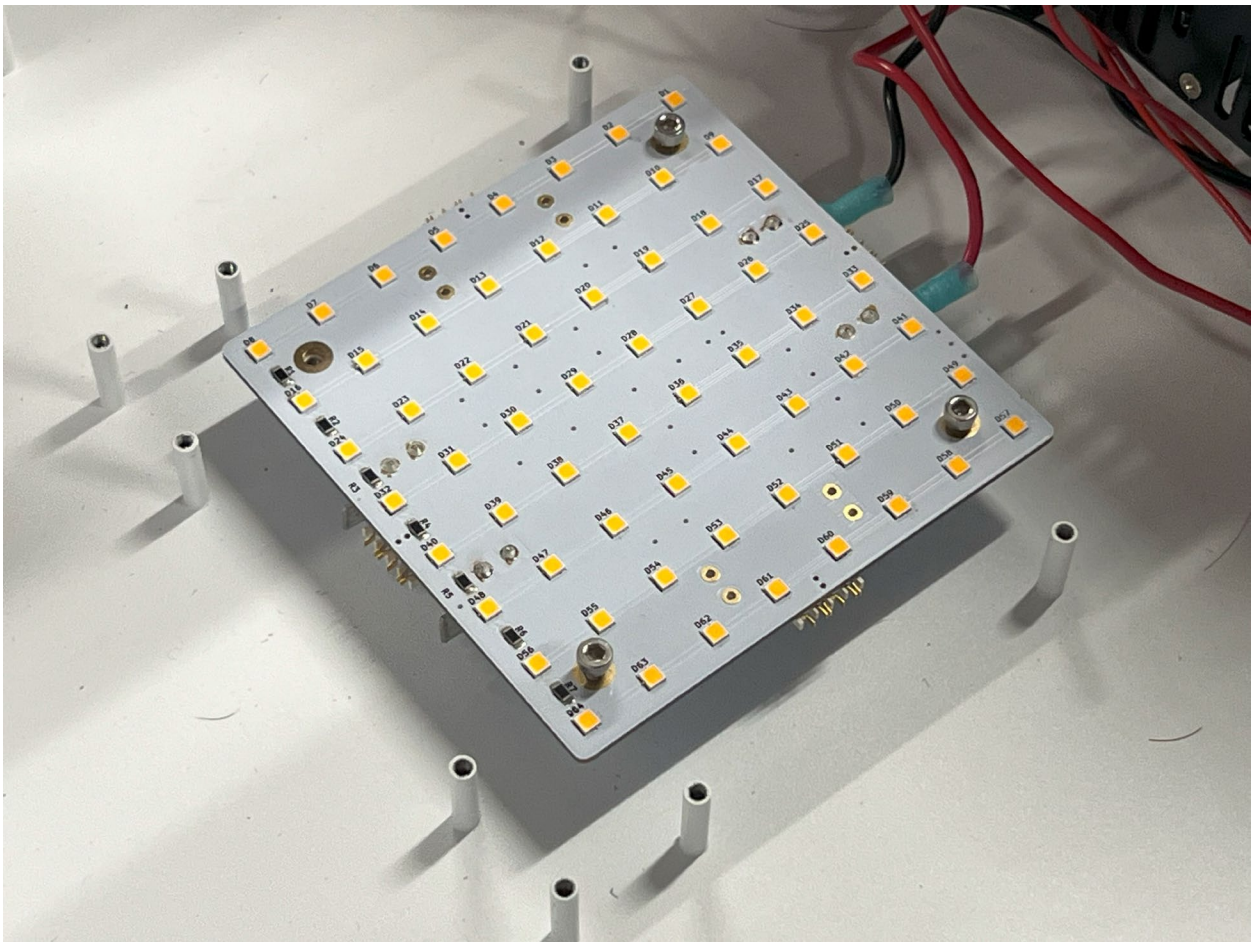

Figure 24: LED board for power input to the floor LEDs

2. Connect the rest of the boards together as in Step 5 of the previous section.
3. On the 4 corners of the PCB array, insert an M3 set screw. **Make sure to not screw them in all the way, as they will be used to mount the Sample Stage**. Screw on the M3 standoffs to the set screw until tight. See Figure 25 for reference.

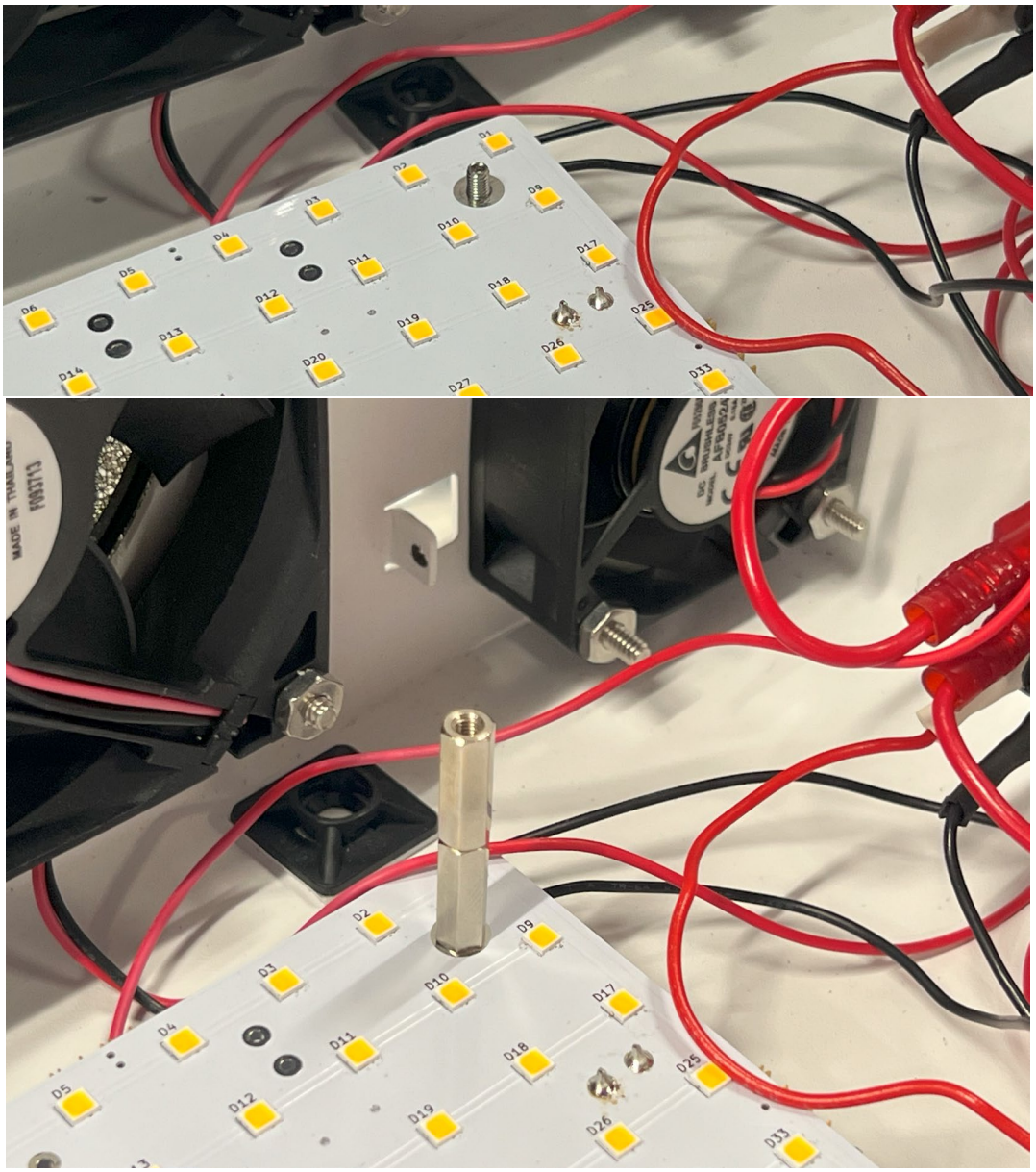

Figure 25: Set screw location and extension above the board (top) with standoffs attached (bottom).

4. Connect the rest of the boards and mount them with M3 screws.

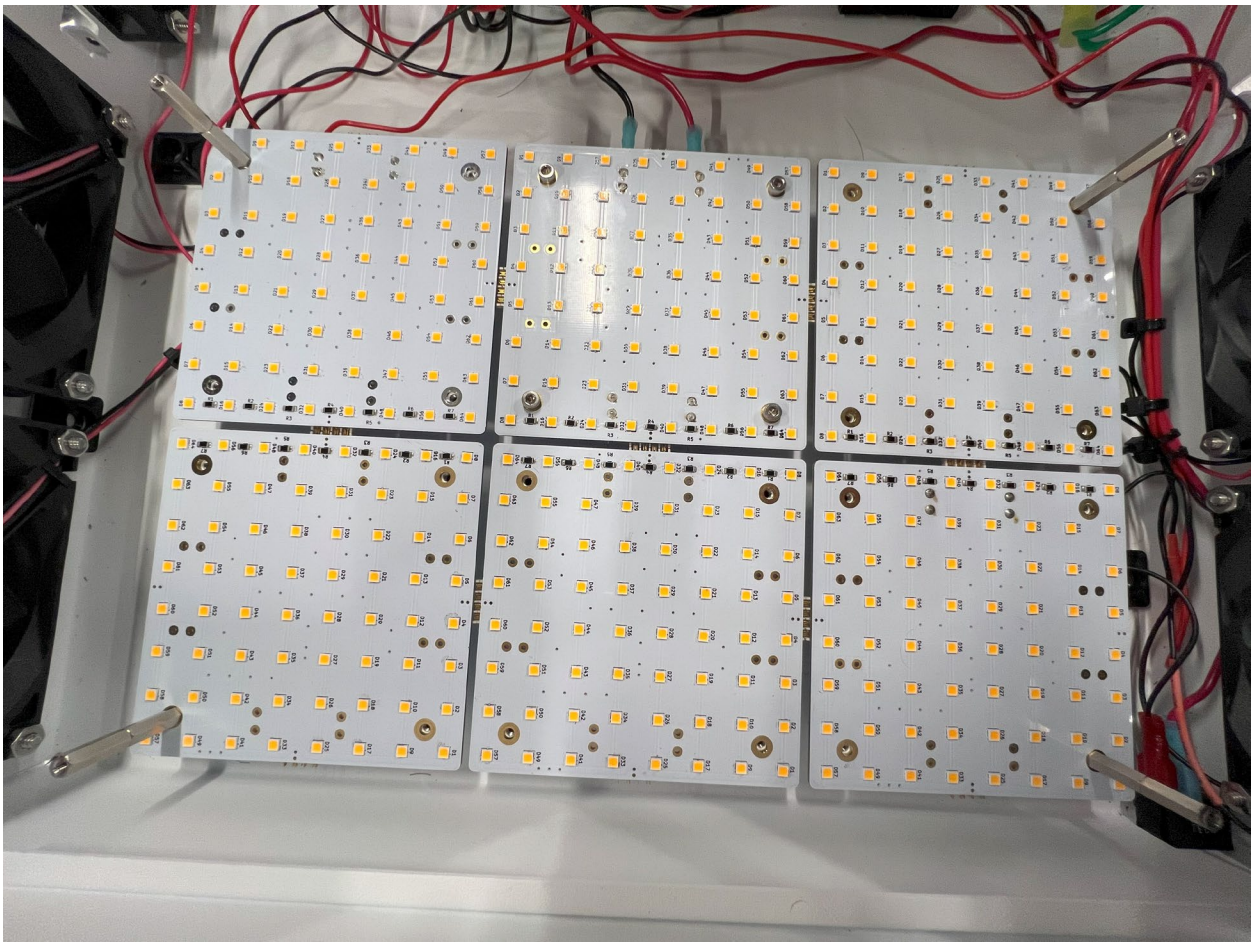

Figure 26: All Floor LEDs assembled and connected. The bulkhead panel is absent in this picture.

X - Sample Stage and Spill Protection Assembly

To protect the electronics on the bottom of the photobleacher, it is important to install a spill protection bezel onto the glass stage. The 3D models are available in the supplemental materials section and may be printed on a large-format 3D printer such as the Prusa XL.

Part 1 - Preparing The Photobleaching Stage:

1. The photobleaching stage should be made from borosilicate glass according to the drawings in the supplemental materials. Our design uses glass of 1/4" nominal thickness but 5 or 6mm thick glass may be substituted. You may also want to send the stage out or devise an alternative mounting scheme if you don't have the tools to work with glass properly. **Note: Acrylic may be used in a pinch, but it is susceptible to corrosion from samples.
2. Using the drawing from the supplemental materials, mark out the hole positions on the glass plate with a marker or scribe and drill the holes with a diamond or carbide drill of appropriate size. Make sure to flood with water during the drilling process as it keeps the tool sharp and keeps the glass dust at bay. Make sure to wear a mask and other appropriate PPE when drilling or cutting glass.
3. Check that the completed holes have the correct spacing according to the drawing.

Part 2 – Adding Spill Protection Bezel and Stage Installation:

1. Prepare a caulk gun with a white or clear RTV Silicone sealant such as Dowsil 732. Place a bead of silicone around the entire inside perimeter shelf of the plastic bezel. The silicone bead should be approximately 3-6mm wide. You do not need much silicone to make a good seal, so you can add some extra and scrape off the excess with a razor blade.
2. Lower the drilled glass stage into the bezel and press gently down to seat it in place. Do not worry about excess silicone sealant at this time. If you see any gaps in the seal between the glass and the bezel, either fill them in, or remove the glass panel and start over. Do not press down too hard on the glass; a thin but finitely thick layer of silicone is necessary for a good seal.

3. Allow the silicone to cure for at least two hours before handling.
4. If there is excess silicone intruding on the stage area, gently trim it off with a razor.
5. Use 4x M3x8mm socket head screws to gently secure the bezel retainer piece in place. It may be necessary to tap the 3D printed holes in the bezel. The bolts need only be installed with the gentlest of torque as the retainer will deform if they are tightened too far. The retainer is not strictly necessary since the bezel bears no weight, but the retainer ensures that it does not fall off if it sustains a great impact. See Figure 27 for reference.

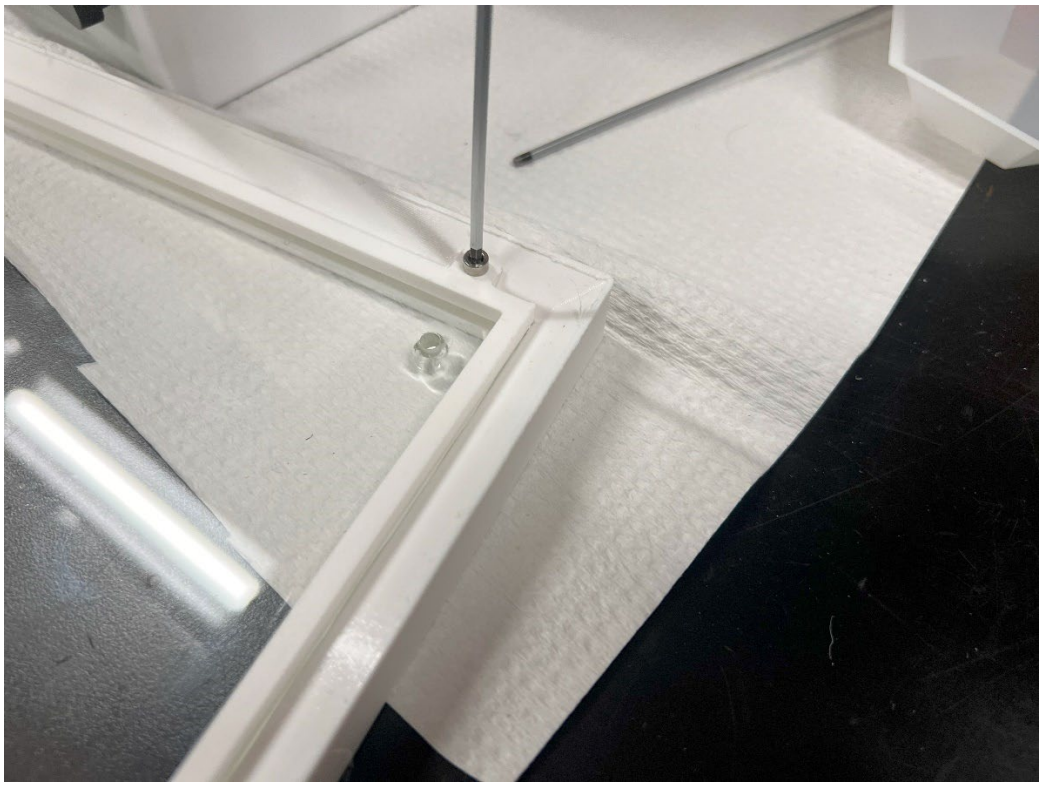

Figure 27: Installation and screw location for the bezel retainer.

6. Lower the stage assembly onto the standoffs inside the lower photobleacher housing. Secure in place with 4x M3x10 bolts. Use an M3 rubber sealing washer (like McMaster P/N 99604A141) to seal the bolt head against the glass. See Figure 28 for reference.

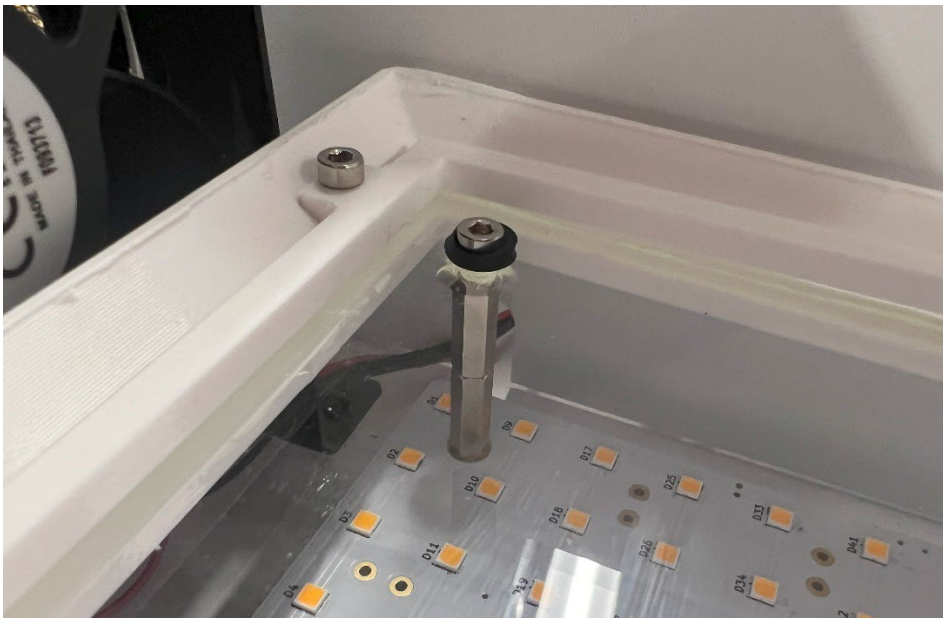

Figure 28: Mounting of the sample stage using rubber washers

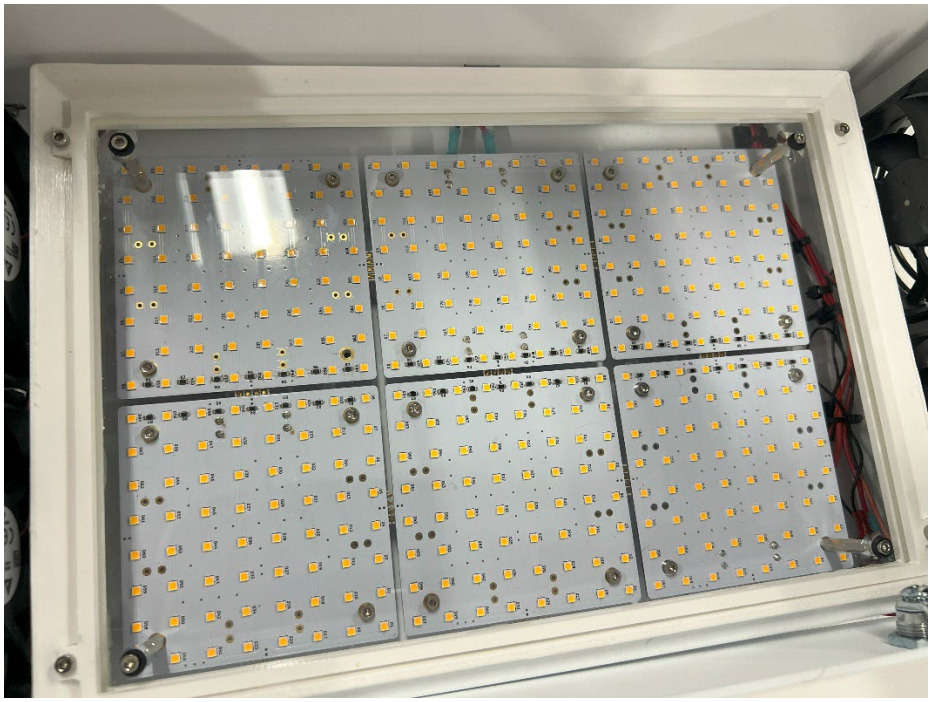

Figure 29: Sample Stage installed and mounted into the photobleacher

XI - Final System Check and First Turn-On

Make sure all components are connected to the appropriate sides of the terminal bus. Then follow the steps in Section VII, Part 2, and turn on the system. All fans and LED panels should turn on. If anything does not turn on, refer to the Troubleshooting Guide.

Closing Up and Final Test:

Once all boards are mounted, align the ceiling mounting holes with the screw holes on the top of the enclosure. Secure with M3 screws and tighten. **Note**: If the ceiling doesn’t lie flat on the top, double check the wires coming from the LED board going to the terminal block. Make sure it is in the gap at the top of the Bulkhead Panel. The fully assembled system is shown in Figure 30.

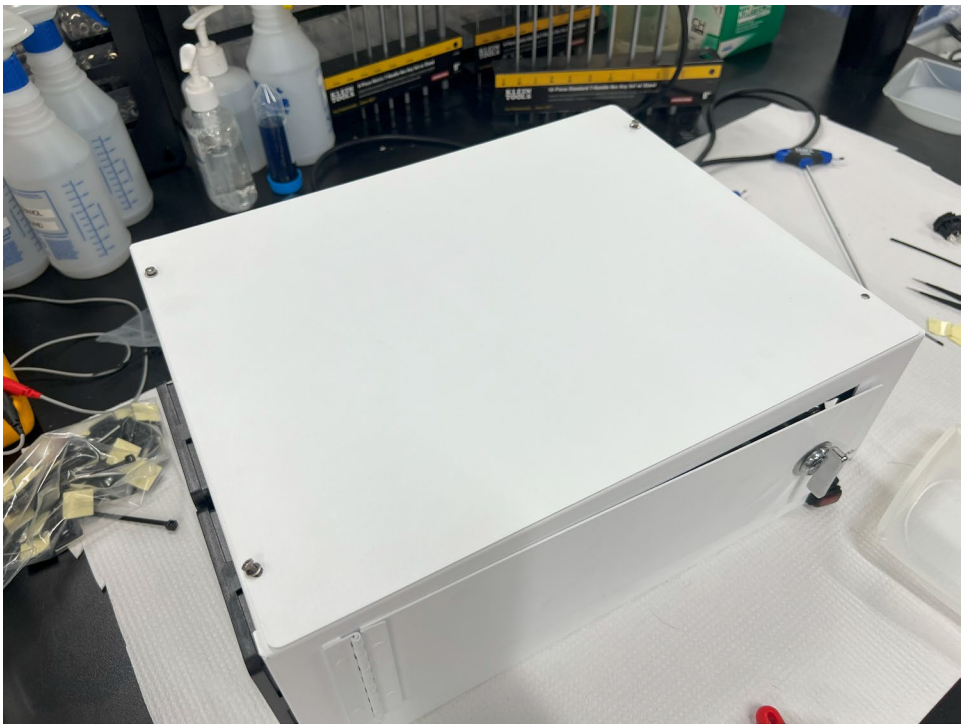

Figure 30: Fully assembled Photobleacher with Ceiling panel screwed in

Once the ceiling is mounted, turn on the system again. Verify again that all fans and LEDs are on (you can look inside through the fan to double check). If everything is on, the system is ready for use.

XII - Troubleshooting Guide

Before checking connections, power down the system, turn all switches to the "OFF" position, and remove the power plug from the back. You can leave the system on if you want to check voltage levels on any of the connections.

This section should be used if any issues arise during the assembly. Using fine tipped probes with the multimeter is very helpful to debug the system.

If there's a short between the +24VDC and –VDC (GND) sides of the terminal bus block:

1. Disconnect everything from the terminal bus and check for a short again. There shouldn't be a short with everything disconnected. **If there's still a short, the terminal bus may be bad, or there may be some metal from the enclosure connecting the two sides**. In either case, remove the terminal bus to double check. If there's still a short, you will need to use a new terminal block. If not, check for exposed metal on the enclosure near the terminal bus mounting location.
2. Check for shorts at the following:
    a. The DC output connector of the DC power supply. Check between the –VDC line (black wire) and the +24 DC line (both red wires).
    b. The power input to the relay (the soldered wires). Check between the –VDC line (black wire) and the +24 DC line (red wire). You may need to remove any heat shrink placed on the tabs to check.

    If there is a short at these connections, remove the wires and check the terminals on the relay and DC power supply. If there is still a short, it's likely the component is damaged and needs to be replaced. If not, re-crimp/re-solder where appropriate and check again.

If the System doesn't turn on:

1. Remove the fuse drawer from the power input module from the back and check the fuse with the multimeter. You should observe a short if the fuse is still good. If there is no connection, replace the fuse (you can also use a fuse with a higher current rating if it's the same size as the one used here).

2. Check the connection between DC power supply and the terminal bus. Check both +24VDC and –VDC lines.
3. Check the connection between the DC power supply and the relay, as well as between the relay and the terminal bus.
4. Check the positioning of the reed switch. Depending on the location of the magnet, the reed switch position may need to be adjusted. **The system should power on when the door handle is turned all the way in the clockwise direction**.
5. Double check the connections between the relay and the front panel on/off switch.

If one or more fans don’t turn on:

1. Remove the fan connections from the terminal bus. Check the positive and negative connections between the ring terminal connector and the terminals on the fans (you may need to remove the label to access the fan terminal). If there is no connection, repeat the steps of Section VI and fix as necessary. Double check for a connection before reconnecting to the terminal bus.
2. If rewiring is necessary, try one of the other wiring suggestions mentioned in Section VI to reduce the chance of an unconnected fan.

If one or more LED boards don’t turn on:

1. The LED boards should have been verified individually before mounting. Check connection between the power input to the board that is not turning on and the +24VDC side of the terminal block. Repeat for the -VDC side.
2. Double check the board-to-board connectors. You may need to remove the screws to better align the connection. Make sure they are connected as shown in Figure 21.