Assembly/Manufacturing Guide

- **Tool Manufacturing**
  - The tools are printed on a Voron 2.4R2 with a StealthBurner Extruder, using these print settings in PrusaSlicer and glue from a BambuLab glue stick to hold the parts in place.
    - Use Prusament PLA as the source material for the printer.
    - The print settings should be set to "0.2mm 0.4nozzle V2 - Revo"
    - For any printer questions the documentation can all be found here.
  - Remove the tools and clean the glue off the surface by running them under water and rubbing the surface.
    - **Note:** The glue also comes off easily if bathed in a warm water solution containing dish soap with some passive movement.
  - Dry the tools with a paper towel or any other method.
  - Insert the 4mm x 2mm Magnets into the tools via a press fit using any sort of pliers or adjustable wrench for leverage.
    - **Note:** Make sure that the Top Magnet Tool has its magnets orientated to clamp onto the Bottom Magnet Tool. To ensure the cubes snap together correctly on top of each other. The Baseplate Magnet Tool should also be able to clamp onto the Bottom Magnet Tool.

- **Cube Manufacturing**
  - The cubes are printed on a Voron 2.4R2 with a StealthBurner Extruder, using these print settings in PrusaSlicer and glue from a BambuLab glue stick to hold the parts in place.
    - Use Prusament PLA as the source material for the printer.
    - The print settings should be set to "0.2mm 0.4nozzle V2 - Revo"
    - For any printer questions the documentation can all be found here.
  - Remove the cubes and clean the glue off the surface by running them under water and rubbing the surface.
    - **Note:** The glue also comes off easily if bathed in a water solution containing dish soap and with passive movement.
  - Dry the cubes with a paper towel or any other method.
  - Insert the 4mm x 2mm Magnets into the cubes via a press fit using the top and bottom magnet tools.
    - **Note:** The top piece will use the Top Magnet Tool, and the bottom piece will use the Bottom Magnet Tool.

- **Inserts and Other Parts**
  - All other parts and inserts are printed using a BambuLab X1-C, using just the default print settings, with slight adjustments here and there to enable support for overhanging surfaces.
    - Print using official BambuLab Glue Sticks and a Smooth Plate.
    - Everything but the lens and laser mounts should be printed in Prusament PLA, the lens and laser mounts are printed in PLA-CF.

- **Lens Assembly**
  - Grab a closed-slotted cube, a correctly sized lens mount, and, if you are not using an SM1 or SM05 mount, its corresponding cover.
  - Cut two 3mm Stainless Steel Rods to a length of 48mm, and grab two M6 set screws of appropriate lengths, and one M4 set screw.
  - Insert the two M6 set screws into the lens mount into the two holes on the side and top.
  - If you are not using an SM1 or SM05 mount, insert the lens with its direction facing forward towards the smaller diameter of the lens mount.
    - Insert the M4 set screw into the small hole on the top right of the lens mount and tighten only until the lens does not move anymore, do not overtighten!
  - If you are using an SM1 or SM05 mount, press fit the lens into the corresponding mount.
  - Insert the Lense Assembly into the cube, with the set screw on the side poking out of the slot on the cube, and tap fit the two 3mm rods into place with a rubber mallet.
  - Fasten the top piece of the cube into the correct spot corresponding to the set screws and the ability to slide the lens back and forth.

- **Laser Assembly**
  - Grab a closed slotted bottom cube piece and a normal top cube piece, whichever laser mount works for your laser source, if need be also include the laser switch for the USB lasers, and whichever corresponding ND filter mount works as well; with the adapters being used with the USB laser sources, and the regular mounts being used for other laser sources.
  - Cut two 3mm Stainless Steel Rods to a length of 98mm, and grab four M6 set screws of appropriate lengths, and two M4 set screws.
  - Insert the two M6 set screws into the laser mounts into the two holes on the side and top.
  - Insert the Laser Mounts into the cubes, with the set screw on the side poking out of the slot on the cube, and tap fit the two 3mm rods into place with a rubber mallet.
  - Insert the laser so that it is within both laser mounts, and if necessary, also include the laser switch for the USB lasers, and fasten it into place using the two M4 set screws on the laser mounting points, do not overtighten!
  - Fasten the top pieces of the cubes into the correct spot corresponding to the set screws and the ability to slide the laser back and forth.

- **Vertical Mirror Assembly**
  - Grab a normal cube, a vertical mirror base, a vertical mirror plate, as well as three M3 Knurled Inserts, three ferrous M3 Screws, and three 5mm Magnets.

- ○ Heat-press the three knurled inserts into the three corresponding holes on the base piece using a [soldering iron attachment](#).
- ○ Press-fit the three magnets into the plate, and then glue a 30mm x 40mm optical mirror surface to the other side of the plate.
- ○ Screw the three screws into the inserts and attach the plate to the ends of the screws using the magnets.
- ○ Slide the assembly into the bottom cube piece and attach the top cube piece.

- **Horizontal Mirror Assembly**
  - ○ Grab a normal bottom cube piece and a closed top cube piece, a horizontal mirror base, a horizontal mirror plate, as well as three [M3 Knurled Inserts](#), three ferrous [M3 Screws](#), and three [5mm Magnets](#).
  - ○ Heat-press the three knurled inserts into the three corresponding holes on the base piece using a [soldering iron attachment](#).
  - ○ Press-fit the three magnets into the plate, and then glue a 30mm x 47.5mm optical mirror surface to the other side of the plate.
  - ○ Screw the three screws into the inserts and attach the plate to the ends of the screws using the magnets.
  - ○ Slide the assembly into the bottom cube piece and attach the top cube piece.

- **Dichroic Assembly**
  - ○ Grab a normal cube, a dichroic mount, an appropriate 25.5mm x 36mm x 1mm dichroic mirror, and appropriate 1" filters.
  - ○ Slot the 25.5mm x 36mm x 1mm dichroic mirror into the corresponding slot.
  - ○ Insert a standard SM1 clip and an appropriate 1" Filter into both circular holes, and then clamp them into place with another SM1 clip.

- **Camera Assembly**
  - ○ Grab a normal cube and a camera mount.
  - ○ Insert the camera mount into the bottom cube piece.
  - ○ Attach the top cube piece.

- **Objective Assembly**
  - ○ Grab a normal cube, and an objective mount.
  - ○ Insert the objective mount into the bottom cube piece.
  - ○ Attach the top cube piece.

- **XYZ Stage Assembly**

  - ○ *Joystick Assembly*

    - ■ Grab the two printed joystick pieces, as well as an [Adafruit Gamepad](#), a [QT/QWIIC Cable](#), and four 4mm x 2mm Magnets.

- Press-fit the magnets into the Joystick Base using the Bottom Magnet Tool.
- Insert the Gamepad into the bottom piece, with the connector at the back facing the opening.
- Place a dab of hot glue on the very edge of the corners of the gamepad and press the top piece into place.
    - **Note:** Take care not to get any hot glue on the joystick or buttons.
- Pull the top piece off of the joystick, put a tiny amount of hot glue in the hole on the top piece, and press fit it back onto the joystick.
    - **Note:** Take care not to let any hot glue drip onto the lower joystick assembly.
- Insert the QT/QWIIC cable into its port, and place a few more dabs of hot glue to hold it in place.

- *Stage Assembly*

    - **Preparation**
        - Grab the printed pieces from the xyz stage, four 2mm Stainless Steel Rods, three M3 x 8mm nuts, thirty-six 4mm x 2mm Magnets, three DC Motors with Screws, three DC Motors with Extended Backs, two Sideways Encoders, one Normal Encoder, eight Low Profile M3 Screws, one Controller Board, four JST-SH Cables, and an Adafruit LED Sequin.
    - Rods
        - Safely cut the stainless-steel rods into the following lengths.
            - Six 48.7mm Z Axis
            - Six 44mm Y Axis
            - Six 39mm X Axis
    - Motors
        - Safely cut the M3 screw rods to the following lengths from the flat surface of the gearbox assembly.
            - One 36.5mm X Axis
            - One 34.5mm Y Axis
            - One 25.5mm Z Axis
        - Unscrew the gearboxes from both sets of motors and take something like a wire stripper to clamp onto and remove the gears from the shaft of each motor.
            - **Note:** Keep track of what gear they are, and which motor they are from and be careful not to damage them.
        - Assemble the M3 gear and gearbox onto the motor with the extended back shaft, press fitting the gear on and then screwing the gearbox back on.
            - **Note:** Careful not to strip the screws, they are very tiny.

- On the Y Axis and Z Axis Motors, solder on the sideways encoder kits.
  - **Note:** Make sure that the polarities on the motor and circuit board are aligned.
- On the X Axis Motor, solder on the normal encoder kit.
  - **Note:** Make sure that the polarities on the motor and circuit board are aligned.
- Press fit the encoder wheel onto the shaft with the dots facing away from the motor, ensuring there is less than a 2mm gap between it and the hall-effect sensors on the board.
- Motor 2040
  - Take the Motor 2040 board, and while holding the Boot/User button plug it into a pc, a device should show up in file explorer.
  - Drop this [UF2 file](#) into the device and keep it plugged in, this will install circuit python onto the board.
  - Once it is installed a device called Circuit Python will show up, and you should copy paste these [library files](#) into the "lib" folder.
  - It will have a file named code.py, open this file with Notepad++, and copy paste [this code](#) over any currently existing code, and save the file.
  - The device will reconnect, and you should see the motor lights indicating they are trying to move, this will happen with or without motors connected.
- Adafruit Sequin LED
  - Take the Adafruit LED and one of the JST-SH cables, plug the JST-SH cable into the Motor 2040, on the cable, cut off the other end as far as you can, and then cut the four wires to the right on the motor 2040 end, leaving the two wires on the left.
    - **Note:** These are the motor power connections, they will be used to power the LED.
  - Solder the right wire, or the one on the inside, to the negative terminal on the LED, and the left wire, or the one on the outside, to the positive terminal on the LED.
    - **Note:** Make sure the led side is facing towards the wires, so that the empty spot with the resistor is facing away from the wires.

- **Assembly**
  - Press-fit the M3 nuts into the side slot on the X Stage Body, Y Stage Body, and Z Stage Part, and secure them in place with a light layer of hot glue on top of them.
  - Press-fit four magnets into the Z Stage Body on the back using the Top Magnet Tool.

- Press-fit eight magnets into the top of the Z Stage Body using the Top Magnet Tool, and the other twenty-four magnets to the bottom using the Bottom Magnet Tool
  - X Axis
    - Grab the X Stage Body and Y Stage Part, and slot the X Body through the Y Part
      - **Note:** The two flat sides should be facing towards each other.
    - Grab the X Stage Part and slot it into the square receptacle on the X Stage Body.
      - **Note:** The larger radius on the X Body should be fitted into the slot on the top of the X Part.
    - Secure the two x stage parts together with one of the low profile M3 screws, do not overtighten!
    - Grab two X Stage Clamps and screw them into the X Part where the two holes are, they will hold your sample plate in place, do not overtighten!
    - Insert the six 39.8mm rods into the Y Stage Body and slide the X Stage Body through them so that the two holes on either part line up.
    - Press-fit the Y Stage Part onto the rails and secure it into place with two low profile M3 screws.
  - X Motor
    - Temporarily hook up the X Axis Motor to the D Spot on the Motor 2040 using a JST-SH cable and plug the joystick's cable into the QW/ST port.
      - **Note:** Make sure you are plugging in the cables correctly or you will damage the pins.
    - Plug in the Motor 2040 to a USB outlet and it will spin the motor in the direction required to screw it into place, making sure to align the motor so that the encoder port points away from the main X/Y Bodies, and let it screw itself all the way in.
    - Grab the X Motor Clamp and attach it to the motor, making sure to line up the holes and inset for the screw head.
    - Secure the motor in place with another low profile M3 screw and disconnect the JST-SH cable from the motor and disconnect the Motor 2040 from USB power.
  - Y Axis
    - Grab the Z Stage Part and insert the assembly so that the M3 nut on the assembly and the corresponding motor mount line up.
    - Insert the six 44mm steel rods into the side of the Z Part, making sure that they pass through the Y Body correctly and are flush with the other side of the Z Part.
  - Y Motor

- Temporarily hook up the Y Axis Motor to the D Spot on the Motor 2040 using a JST-SH cable
  - **Note:** Make sure you are plugging in the cables correctly or you will damage the pins.
- Plug in the Motor 2040 to a USB outlet and it will spin the motor in the direction required to screw it into place, make sure to align the motor so that the encoder port points towards the X Axis Sample Clamps, and let it screw itself all the way in.
- Grab the Y Motor Clamp and attach it to the motor, making sure to line up the holes and inset for the screw head.
- Secure the motor in place with another low profile M3 screw and disconnect the JST-SH cable from the motor and disconnect the Motor 2040 from USB power.

  - Z Axis
    - Grab the Z Stage Body and insert the assembly so that the M3 nut on the assembly and the corresponding motor mount line up.
    - Insert the six 48.7mm steel rods into the bottom of the Z Body, making sure that they pass through the Z Part correctly and that they are fully inserted and not sticking out from the bottom.
      - **Note:** You may need to use some force from a mallet to tap them into place fully. Make sure to be gentle though as you can split your printed part with too much force, if necessary, use one of the magnet tools for the cubes to support the edge.

  - Z Motor
    - Temporarily hook up the Z Axis Motor to the D Spot on the Motor 2040 using a JST-SH cable.
      - **Note:** Make sure you are plugging in the cables correctly or you will damage the pins.
    - Plug in the Motor 2040 to a USB outlet and it will spin the motor in the direction required to screw it into place, make sure to align the motor so that the encoder port points towards the X Axis Sample Clamps, and let it screw itself all the way in.
    - Grab the Z Motor Clamp and attach it to the motor, making sure to line up the holes and inset for the screw head.
    - Secure the motor in place with another low profile M3 screw and disconnect the JST-SH cable from the motor and disconnect the Motor 2040 from USB power.

- **Electronics Assembly**
  - Motor 2040
    - Grab the Motor 2040 with the LED plugged into port A on the board and mount it to the top of the Z Axis Body using a dab of hot glue in each corner.

- ○ **Note:** The USB-C port and other corresponding ports will line up where you should place the board.
  - ■ Adafruit Sequin LED
    - ● Mount the LED to the Z Stage LED Mount using hot glue to hold it in place to the recess on the underside with the wires being hot glued there as well.
    - ● Mount the LED Mount to the stage making sure to line up the wires with the channel on the top.
      - ○ **Note:** The hot glue gun will melt the wire's insulation away, so be careful to only let the hot glue touch them.
    - ● Mount the wires into the recessed channel that runs to the motor 2040, leaving some slack on the Motor 2040 side.
      - ○ **Note:** The hot glue gun will melt the wire's insulation away, so be careful to only let the hot glue touch them.
  - ■ Motors
    - ● Connect the X Axis Motor to the D Port on the Motor 2040 using a JST-SH Cable, and then put a dab of hot glue on both connections to secure them in place.
    - ● Connect the Y Axis Motor to the C Port on the Motor 2040 using a JST-SH Cable, and then put a dab of hot glue on both connections to secure them in place.
    - ● Connect the Z Axis Motor to the B Port on the Motor 2040 using a JST-SH Cable, and then put a dab of hot glue on both connections to secure them in place.
  - ■ As a finishing touch, attach the Electronics Cover to the stage above the Motor 2040 using a dollop of hot glue in each corner, and then press fitting it into the correct direction and orientation.