# DOCUMENTATION FOR 3-MOUSE INTERACTION RIG
## Total Cost ~ $ 8916 USD

**Note: Some costs are approximations or subject to change over time. There may be variations when attempting to reproduce.**

## LED LIGHT GUIDE PART LIST

### Bought Parts

| Manufacturer | Name | Part ID | Quantity | Cost | Sub-Total |
|---|---|---|---|---|---|
| Thorlabs | Liquid Light Guide, Ø3 mm Core, 340 - 800 nm, 4' (1.2 m) Length | LLG03-4H | 3 | $418.14 | $1254.42 |
| Thorlabs | SM1 Lens Tube, 3.00" Thread Depth, One Retaining Ring Included | SM1L30 | 6 | $29.23 | $175.38 |
| Thorlabs | SM1 Lens Tube, 2.00" Thread Depth, One Retaining Ring Included | SM1L20 | 3 | $17.85 | $53.55 |
| Thorlabs | SM1 Lens Tube, 1.00" Thread Depth, One Retaining Ring Included | SM1L10 | 3 | $15.41 | $46.23 |
| Thorlabs | SM1 Lens Tube, 0.50" Thread Depth, One Retaining Ring Included | SM1L05 | 6 | $13.62 | $81.72 |
| Thorlabs | f=30.0 mm, Ø1" Achromatic Doublet, ARC: 400-700 nm | AC254-030-A | 3 | $96.22 | $288.66 |
| Thorlabs | N-BK7 Bi-Convex Lens, Ø1", f = 25.4 mm, Uncoated | LB1761 | 6 | $30.17 | $181.02 |
| Thorlabs | Ø3 mm LLG to SM1 Adapter | AD3LLG | 3 | $38.32 | $114.96 |
| Thorlabs | 30 mm Cage Cube with Dichroic Filter Mount | CM1-DCH | 6 | $192.44 | $1154.64 |
| Thorlabs | Cage Cube Connector for Compact 30 mm Cage Cubes | CM1-CC | 3 | $53.47 | $160.41 |
| Thorlabs | 25 mm x 36 mm Longpass Dichroic Mirror, 550 nm Cut-On | DMLP550R | 3 | $279.16 | $837.48 |

| Thorlabs | Hard-Coated Bandpass Filter, Ø25 mm, CWL = 440 nm, FWHM = 10 nm | FBH440-10 | 3 | $164.67 | $494.01 |
|---|---|---|---|---|---|
| Thorlabs | SM1 Retaining Ring for Ø1" Lens Tubes and Mounts, 10 Pack | SM1RR-P10 | 1 | $43.81 | $43.81 |
| Chroma | Dichroic Filter, 455 nm, Size: 26 * 38 mm | AT455DC | 3 | $175.00 | $525.00 |
| Chroma | Bandpass Filter, 480 nm, Size: 25mmR R=Mounted in Ring | ET480/30x | 3 | $365.00 | $1095.00 |
| Luxeonstar | Royal-Blue (448 nm) Rebel LED on a SinkPAD-II 20mm Star Base – 1030 mW @ 700mA | SP-01-V4 | 3 | $8.33 | $24.99 |
| Luxeonstar | Blue (470 nm) Rebel LED on a SinkPAD-II 10mm Square Base - 65 lm @ 700mA | SP-05-B4 | 3 | $10.18 | $30.54 |
| **TOTAL** | | | | | **$6561.83** |

## Customized Parts

| Name | File Name | Quantity | Method |
|---|---|---|---|
| LED Mount Top | Milled as-1.50_2_v2.STL | 6 | Machined |
| LED Mount Spacer | Spacer_with_wire_hole_as-.500_v2.STL | 6 | Machined |
| LED Mount Bottom | LED_mount_as-1.50_v2.STL | 6 | Machined |

# RIG PART LIST

## Bought Parts

| Manufacturer | Name | Part ID | Quantity | Cost | Sub-Total |
|---|---|---|---|---|---|
| N/A | ¼-20 Set Screws, Bolts, Nuts, Washers; M2 Screws, Nuts | N/A | Enough | N/A | N/A |
| N/A | 1.5 Inch Outer Diameter 1⅛ Inch Inner Diameter Acrylic Tubing | N/A | 12 Inch Length | N/A | N/A |

| | | | | | |
|---|---|---|---|---|---|
| Thorlabs | Clamping Fork, 1.24" Counterbored Slot, Universal | CF125 | 2 | $9.68 | $19.36 |
| Thorlabs | Ø1/2" Optical Post, SS, 8-32 Setscrew, 1/4"-20 Tap, L = 4", 5 Pack | TR4-P5 | 1 | $30.00 | $30.00 |
| Thorlabs | Ø1/2" Optical Post, SS, 8-32 Setscrew, 1/4"-20 Tap, L = 3" | TR3 | 3 | $5.65 | $16.95 |
| Edmund Optics | 6" Length, 8-32 Stud, Steel Post | #58-966 | 2 | $12.50 | $25.00 |
| Edmund Optics | 12" x 12", Breadboard | #53-830 | 2 | $189.00 | $378.00 |
| Edmund Optics | 4" Length, ¼-20 Thread, Post Holder | #58-980 | 1 | $15.50 | $15.50 |
| Edmund Optics | 12.7mm - 12.7mm (Fixed), Right Angle Post Clamp | #53-357 | 3 | $26.60 | $79.80 |
| Edmund Optics | 12.7mm - 12.7mm (Rotatable), Right Angle Post Clamp | #58-994 | 6 | $31.00 | $186.00 |
| Edmund Optics | 50 x 50mm 80R/20T, VIS Plate Full-Band Beamsplitter | #68-429 | 1 | $274.00 | $274.00 |
| Siskiyou | AS-.500 Aluminium Spacer 0.5 Inches Package of 4 (1 Inch diameter) | 60400000E | 3 | $22.00 | $66.00 |
| Siskiyou | AS-2.00 Aluminium Spacer 2 Inches Package of 4 (1 Inch diameter) | 60430000E | 3 | $32.00 | $96.00 |
| Siskiyou | AS-.250 Aluminium Spacer 2 Inches Package of 4 (1 Inch diameter) | 60390000E | 2 | $19.00 | $38.00 |
| Raspberry Pi / PiShop | Flex Cable for Raspberry Pi Camera - 1 meter | 471 | 3 | $3.61 | $10.83 |
| Taobao (Meike Chuandong) | Motor Driven Industrial Slide Rail with Supports (2 attached platforms) | ZH4920 | 1 | ~ $188.17 | ~ $188.17 |
| **TOTAL** | | | | | **~ $1423.61** |

## Electronics

| Manufacturer | Name | Part ID | Quantity | Cost | Sub-Total |
|---|---|---|---|---|---|
| RaspberryPi / PiShop | Raspberry Pi Model 4b (8 GB RAM) | 8GB-9006 | 4 | $76.51 | $306.04 |
| Waveshare | RPi Camera (B), Adjustable-Focus | RPi Camera (B) | 3 | $15.99 | $47.97 |
| Aegis Electronic | Omron USB3 Vision CMOS Camera, 0.4 MP, Monochrome, Cased | STC-MBS43U3V | 1 | $395.13 | $395.13 |
| Amazon/Best Buy | 30fps Webcam (HBV-W202012HD) | N/A | 1 | ~ $11.00 | ~ $11.00 |
| Amazon | Fosa 140 LED Waterproof Infrared Night Vision Light | N/A | 2 | ~ $14.60 | ~ $29.20 |
| LabJack | LabJack U3-LV | LabJack U3-LV | 1 | $116.64 | $116.64 |
| Sparkfun | Stepper Motor - 125 oz.in (200 steps/rev, 600mm Wire) | ROB-13656 | 1 | $24.42 | $24.42 |
| N/A | LED Driver | N/A | 4 | N/A | N/A |
| N/A | Transistor-transistor logic (TTL) output power supply unit | N/A | 4 | N/A | N/A |
| N/A | Computer | N/A | 1 | N/A | N/A |
| **TOTAL** | | | | | **~ $930.40** |

## Customized Parts

| Name | File Name | Quantity | Method |
|---|---|---|---|
| Pi Camera Holders | pi-camera-holder_v2L.stl OR pi-camera-holder_v2R.stl | 3 | 3D Printing |
| Head-fixing Clamps | Head-fixing Clamp.STEP | 6 | CNC or other metal processing |
| Head-fixing Bars | Head-fixing Bar.STEP | 6 | CNC or other metal processing |
| Transparent Acrylic Tubes | Acrylic_Tube_Mockup.STL Cut a 3 ¾ inch length of tubing, then remove the top half starting from one end to ¾ of an inch into the tube. | 3 | Any clean cutting method |

| Tube-Holding Base | mouse-tube-holder_imperial_modified.stl | 3 | 3D Printing |
|---|---|---|---|
| Beam Splitter Holder | beamsplitter_behavior.stl | 1 | 3D Printing |
| Whisker Imaging Background | N/A | 1 | Any white board/background works |
| Flexible Rail Adaptors | rail_flexible_adaptor.stl | 2 | Any mechanical processing |
| Rail Mockup | rail.STEP | 1 | Virtual Mockup Only |

# LED LIGHT GUIDE ASSEMBLY

1) Insert the 550 nm longpass dichroic mirror and 455 nm dichroic mirror into cage cubes
2) On the top face of the 550 nm cage cube, attach in order:
   a) 0.50'' Lens Tube
   b) 480 nm Bandpass Filter
   c) 3.00'' Lens Tube
   d) Bi-Convex Lens
   e) 470 nm Blue LED (attached to LED mount)
3) On the top face of the 455 nm cage cube, attach in order:
   a) 1.00'' Lens Tube
   b) 0.50'' Lens Tube
   c) 440 nm Bandpass Filter
   d) 3.00'' Lens Tube
   e) Bi-Convex Lens
   f) 448 nm Royal Blue LED (attached to LED mount)
4) Connect both cage cubes together using the connector
5) On the other side of the 455 nm cage cube, attach in order:
   a) 2.00'' Lens Tube
   b) Achromatic Doublet
   c) Liquid Light Guide Adapter
   d) Liquid Light Guide

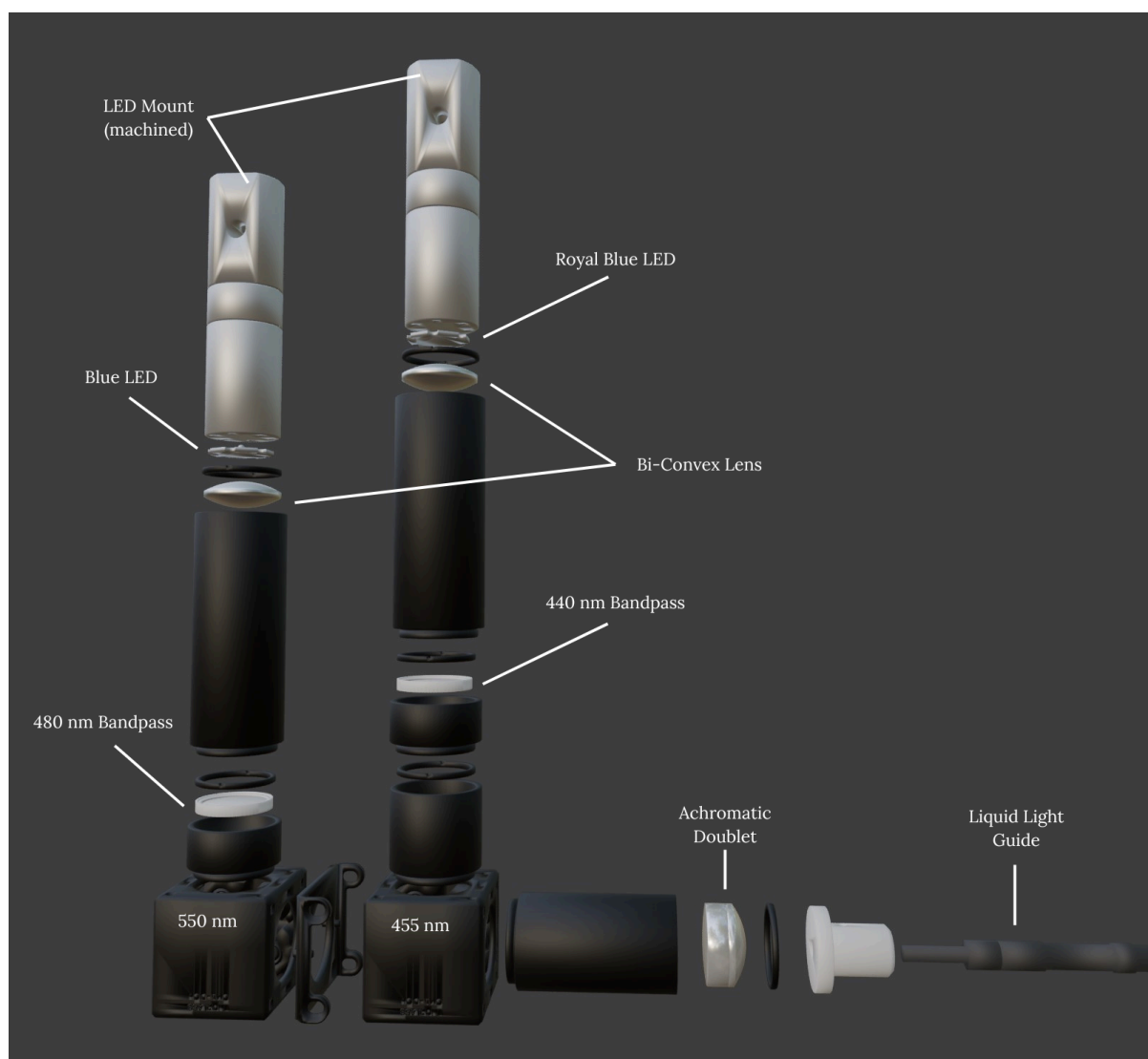Repeat these instructions to build 3 LED Light Guides, one for each mouse in the interaction rig.

Figure 1. Liquid Light Guide Setup

# RIG ASSEMBLY

1) Attach the rail system securely down onto a surface.
2) Screw a tube-holding base onto each sliding platform on the rails, and fix them 50 cm apart (25 cm away from the center).
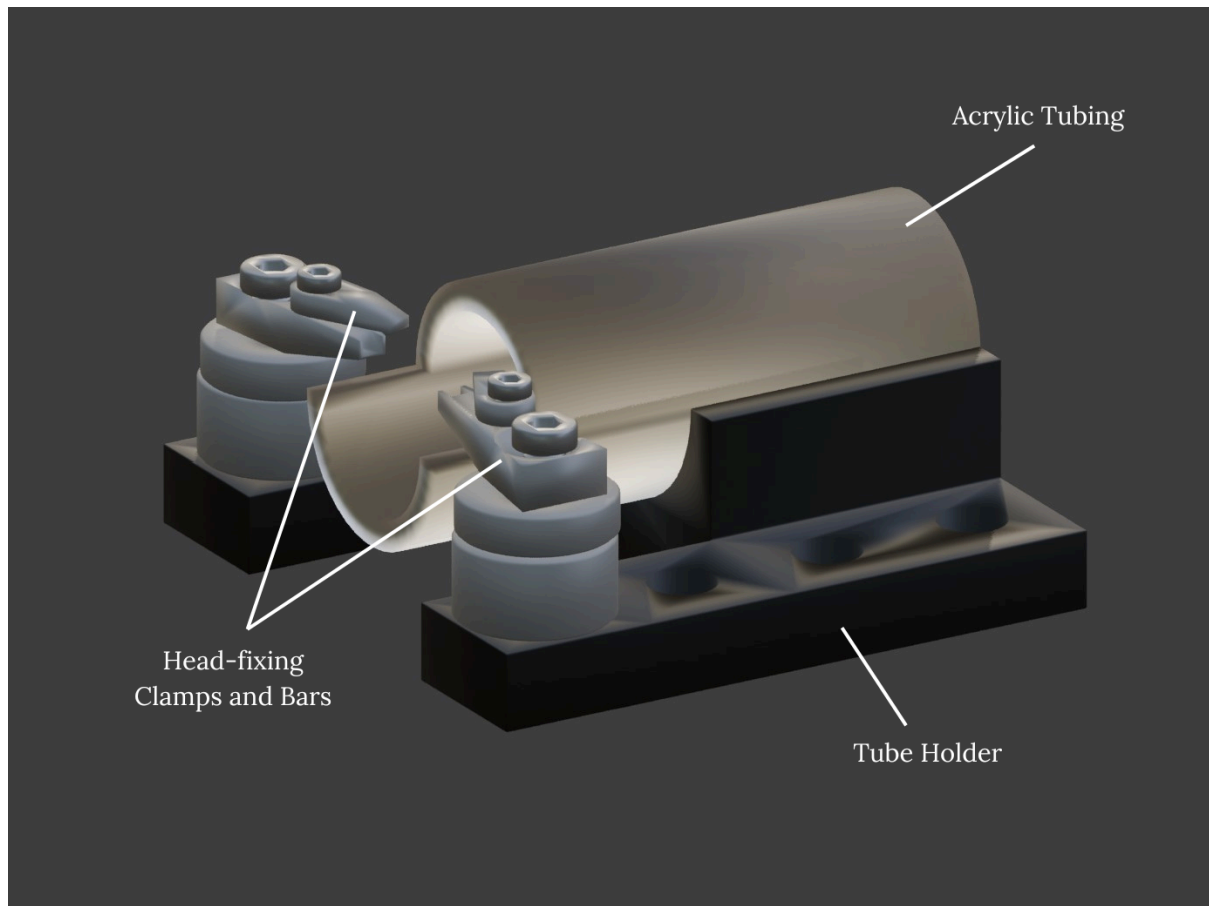


Figure 2. Mouse Tube Setup (Step 3)

3) Do the following for each tube-holder:
   a) Superglue the cut acrylic tubing into the holder with the open side of the tube coinciding with the longer edges of the base.
   b) Screw a 0.50 inch spacer and 0.25 inch spacer onto the last hole on both sides of the base.
   c) Onto each spacer stack, attach a head-fixing clamp and then a head-fixing bar on top. The clamps should be positioned towards the open end of the tube.
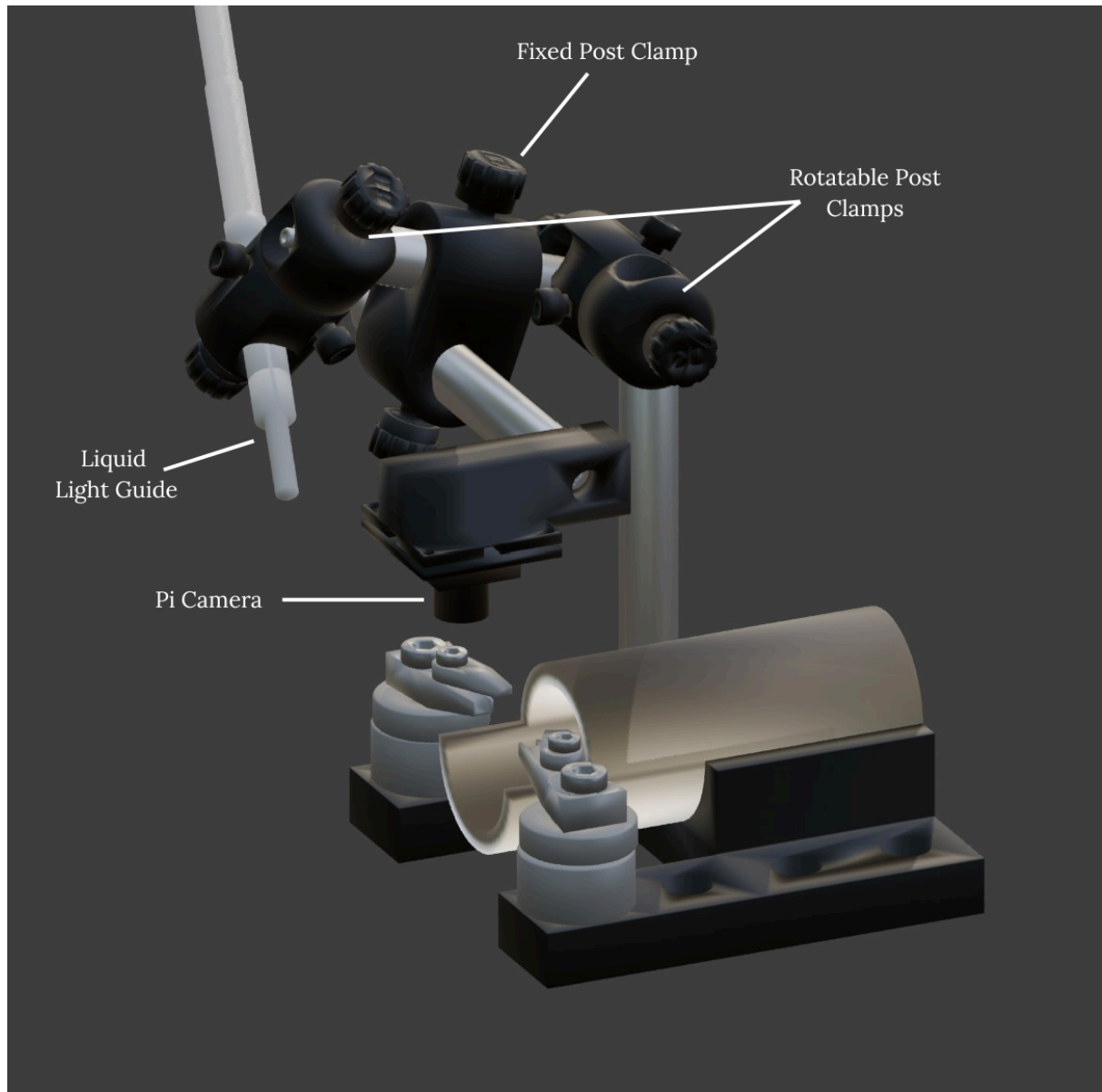
Figure 3. Mouse Platform Setup on Rail (Step 4)

4) For each rail platform:
   a) Screw a 4'' post on one side of the tube and place a rotatable right angle post clamp on the end.
   b) Through the other opening on the clamp, parallel to the tubing, insert a 3'' inch post. Slide a fixed right angle post clamp onto the middle of the post and another rotatable right angle clamp onto the end.
   c) Slide one end of a Liquid Light Guide into the rotatable right angle clamp and ensure that it is pointing towards the area where the mouse window would be.
   d) Insert a 4'' post through the unoccupied hole of the fixed right angle clamp and on the other end, place a pi camera holder equipped with a pi camera. The pi camera should point towards the tube opening.
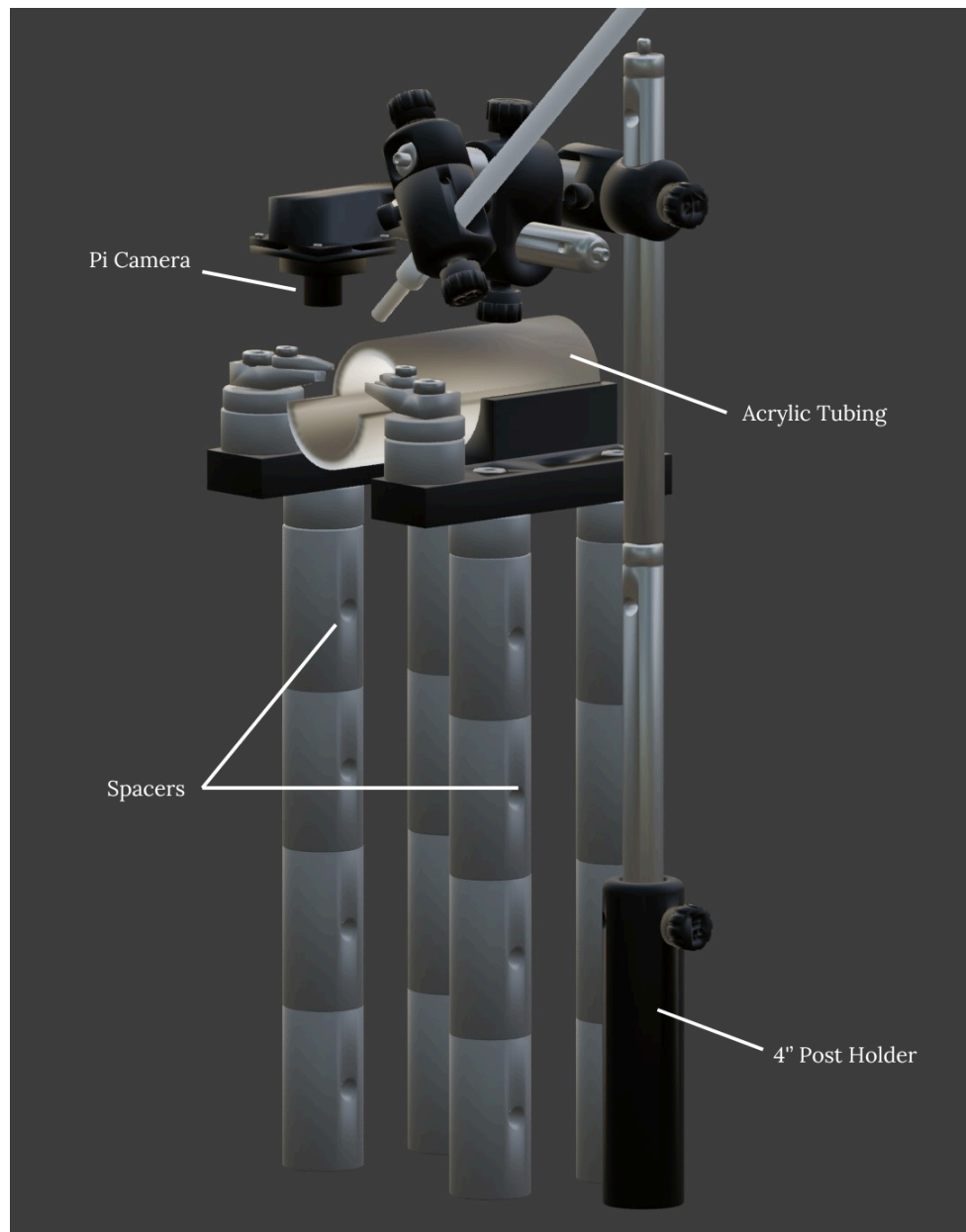
Figure 4. Mouse Platform Setup on Tower (Steps 5-7)

5) Using 2 inch and 0.5 inch spacers, build a 4-corner tower platform behind the center of the rail to hold the final tube holder at equal height to those on the rail. When mice are in the tubes, there should be about 6-12 mm of space between the snouts of those on the rail and tower. Clamping forks can be used to ensure tower legs remain stable.
6) Next to the towered platform, place a 4'' post holder and stabilize it with a clamping fork. Insert two 6'' posts, then place a rotatable right angle clamp 1 inch from the end.
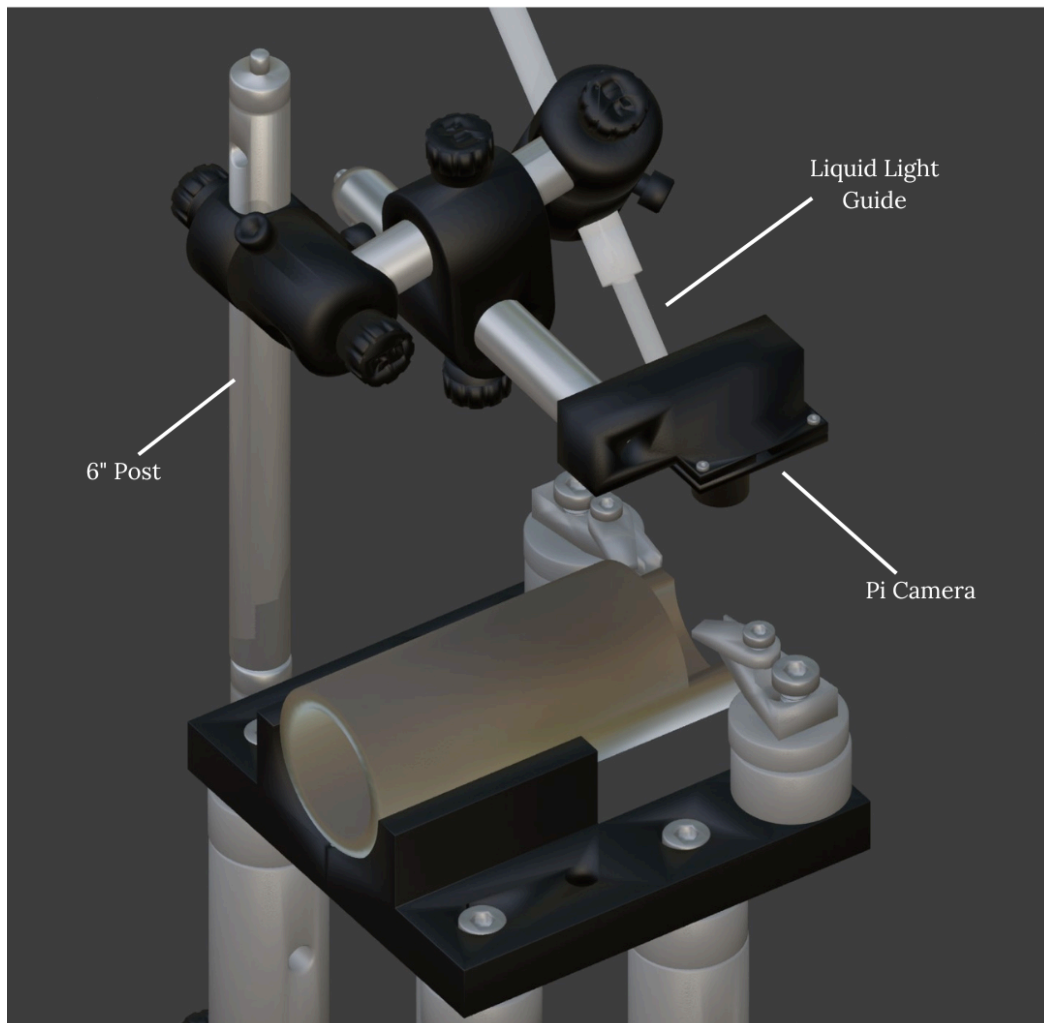7) Repeat steps 4b to 4d for the final platform.

Figure 5. Mouse Platform Setup on Tower, Back, Zoomed In (Steps 6-7)

8) Use MIPI cables to attach each pi camera to an individual Raspberry Pi unit.
9) Underneath the stationary mouse, between the tower platform and the rail, place an HD camera to record mouse limb movement. This should sit in the bottom slot of the 3D printed beamsplitter holder, pointed up to where the beam splitter is inserted.
10) Bracket the HD camera with two infrared lights to illuminate the interaction area. Adjust height using spacers as necessary.
11) Place a high speed camera pointed towards the illumination area to record whisker movement.
12) Attach a stepper motor to the rig and connect it to a driver.
13) Have a fourth Raspberry Pi unit connect to the stepper motor and LED drivers to act as a control center for rig movement and lighting.