DOCUMENTATION FOR 3-MOUSE INTERACTION RIG
Total Cost ~ $ 8731 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.SLDPRT	6	Machined
LED Mount Spacer	Spacer_with_wire_hole_as-.500_v2.SLDPRT	6	Machined
LED Mount Bottom	LED_mount_as-1.50_v2.SLDPRT	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	~ $3.40	~ $3.40
TOTAL					**~ $1238.84**

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.

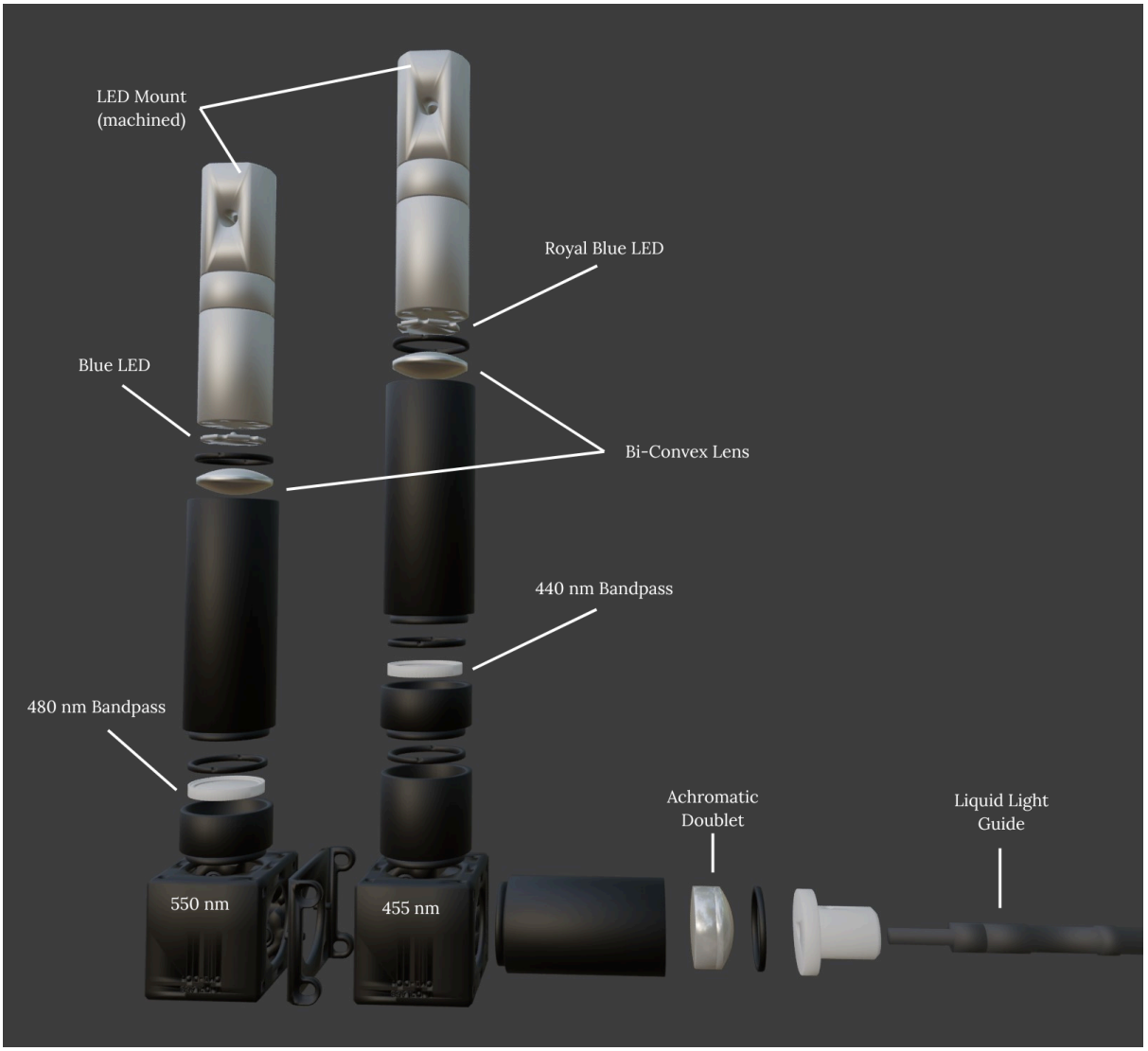

Figure 1. Liquid Light Guide Setup

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).

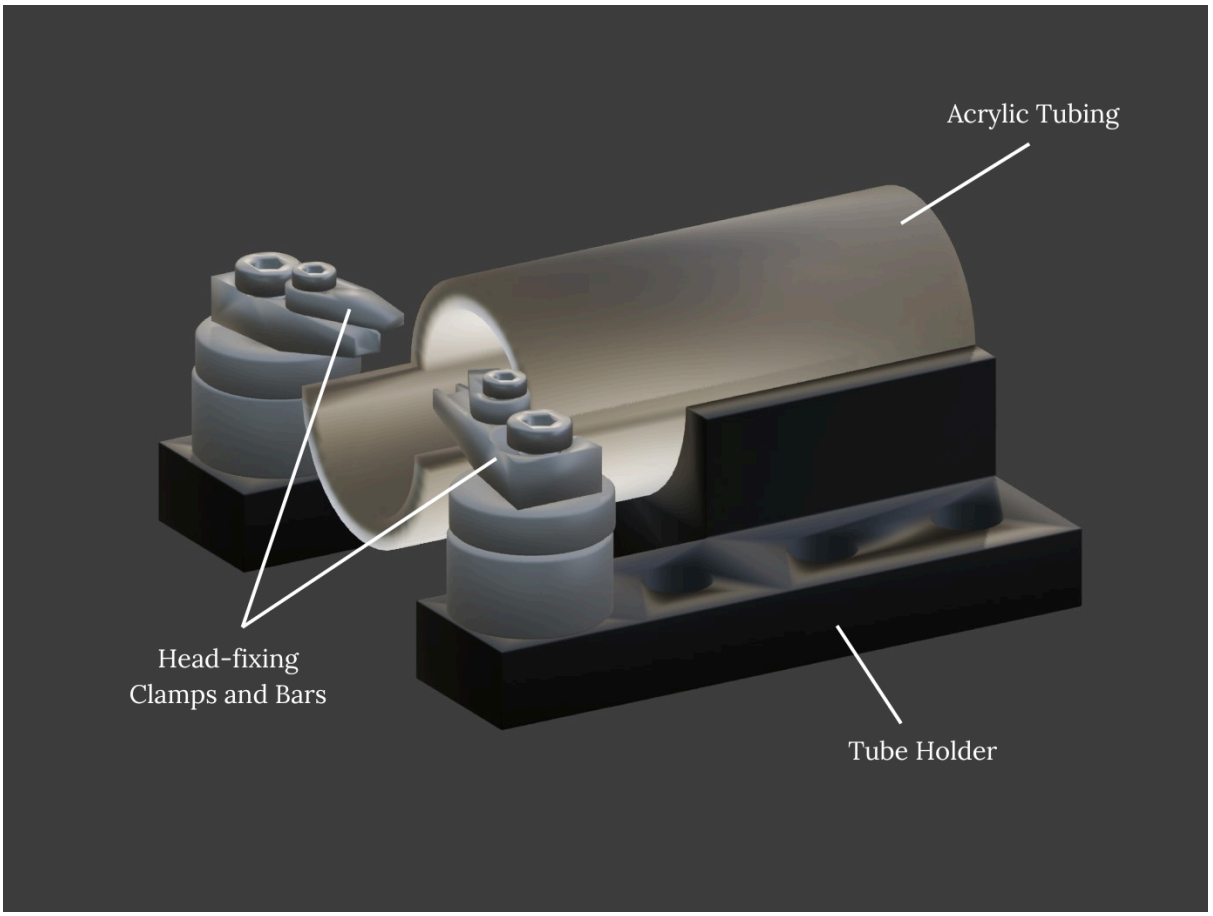

Figure 2. Mouse Tube Setup (Step 3)

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.

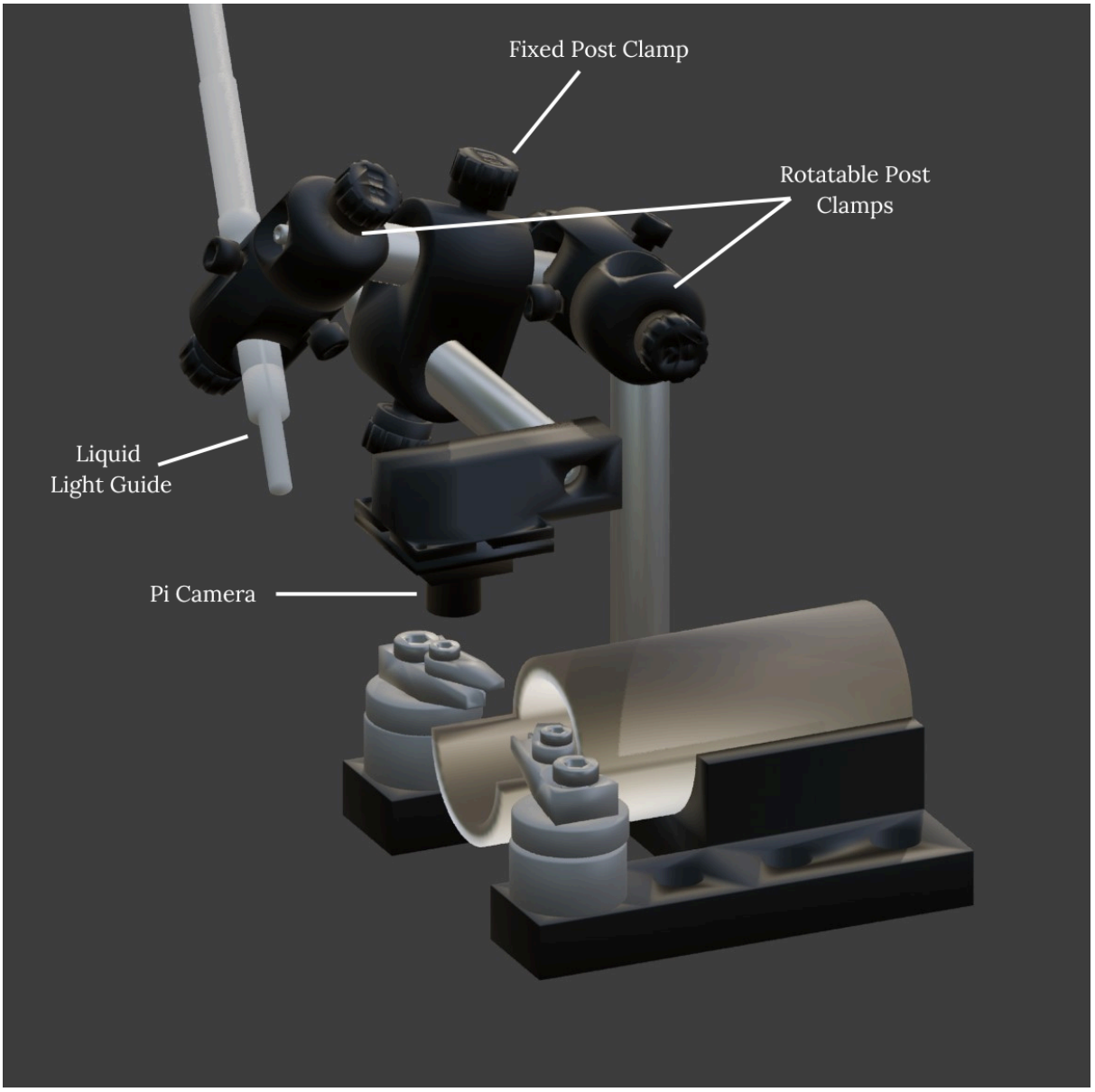

Figure 3. Mouse Platform Setup on Rail (Step 4)

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.

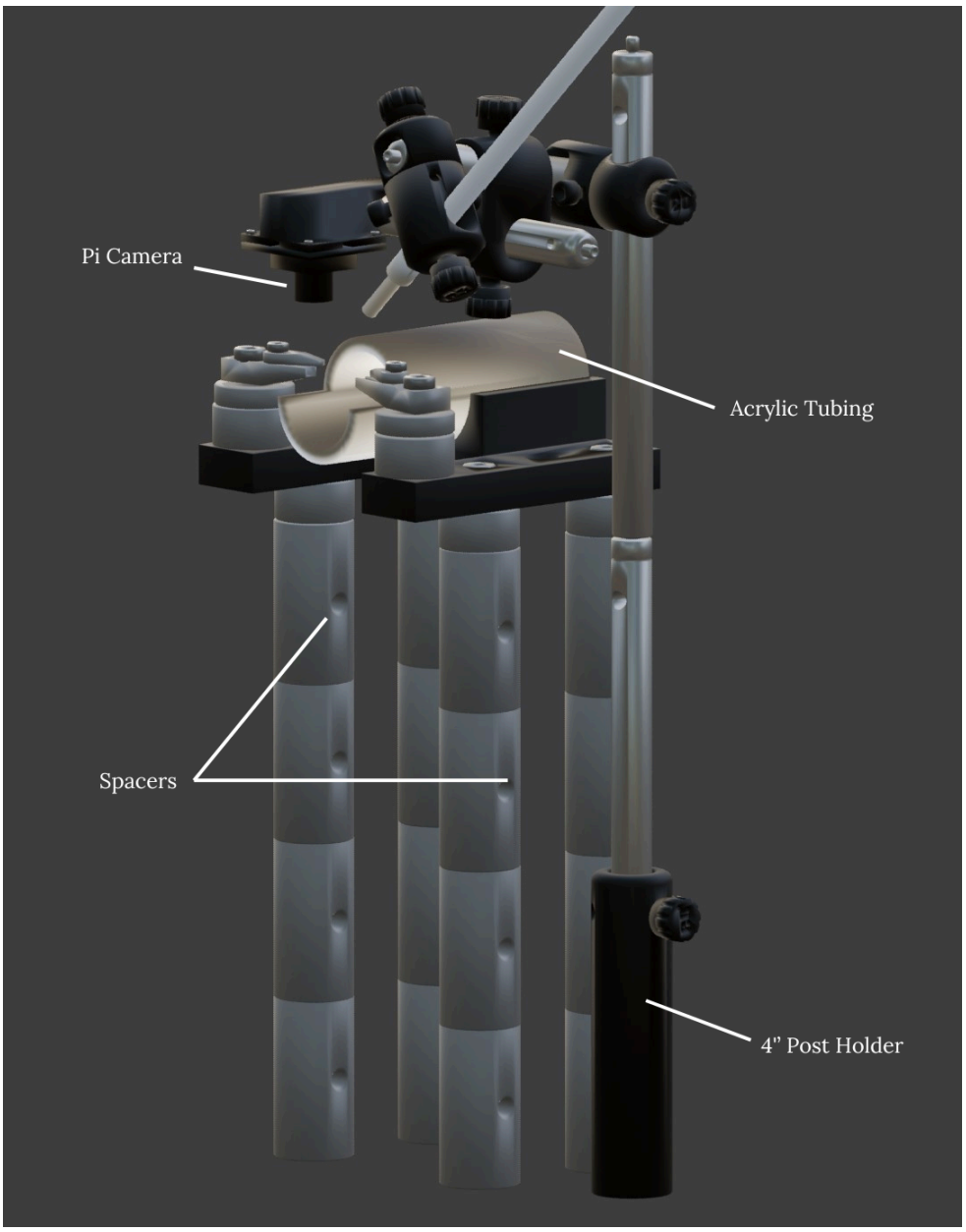

Figure 4. Mouse Platform Setup on Tower (Steps 5-7)

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.

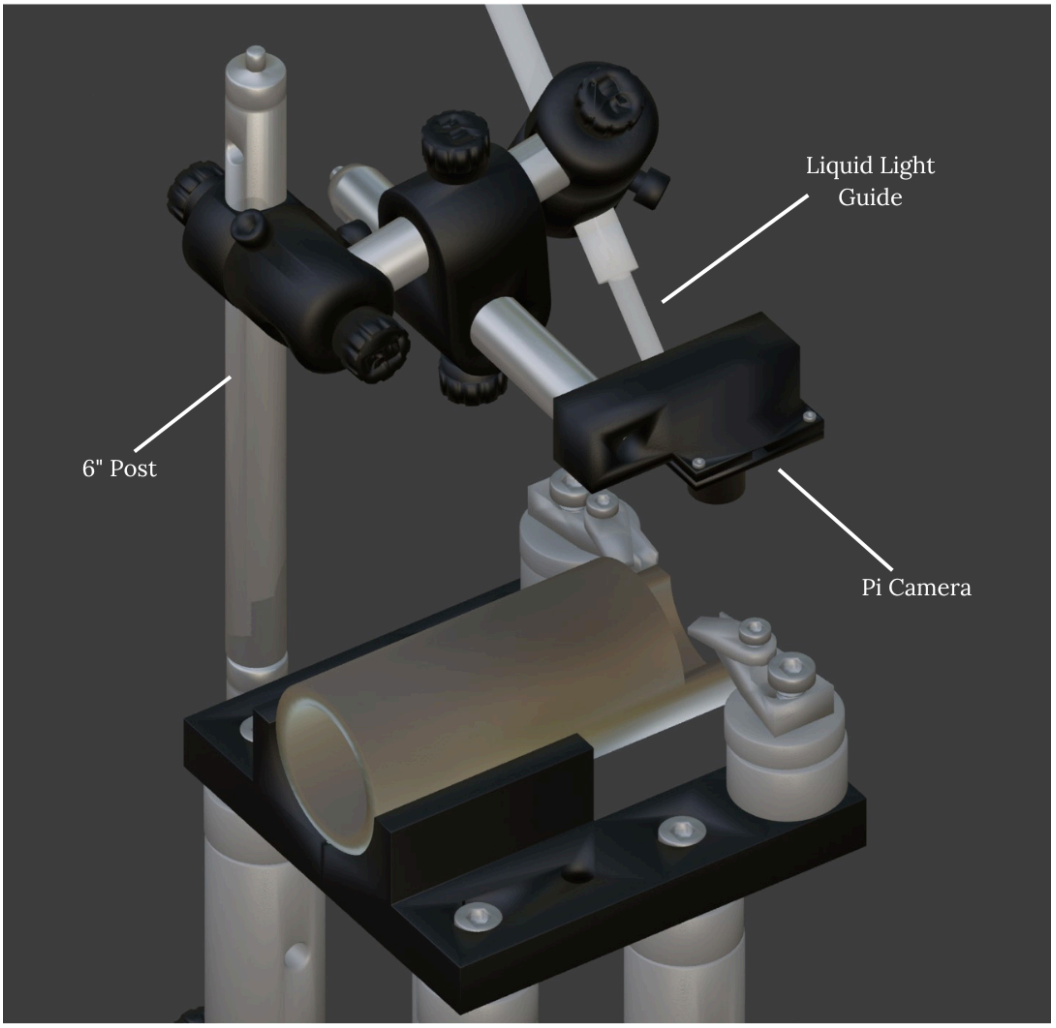

Figure 5. Mouse Platform Setup on Tower, Back, Zoomed In (Steps 6-7)

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.