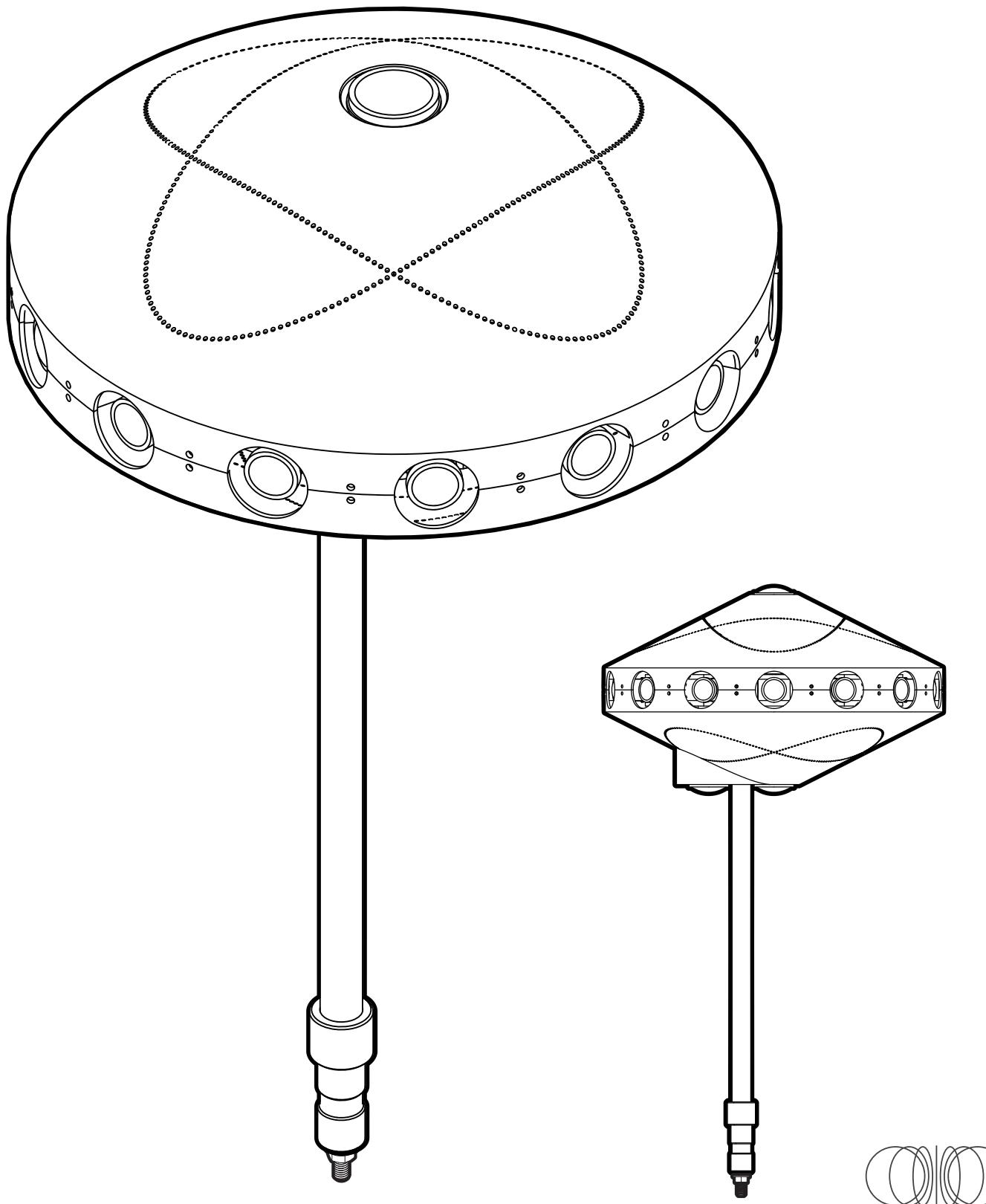


**facebook**

# SURROUND 360





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**System Specifications**

# 1

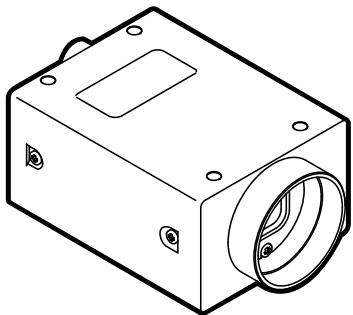
## Parts List

# 1

## 1.

### Camera & Lenses

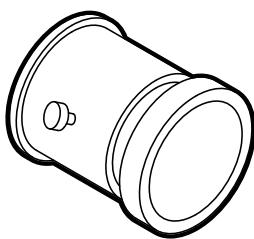
**17x**



**Camera**

Point Grey GS3-U3-41C6C-C

**14x**



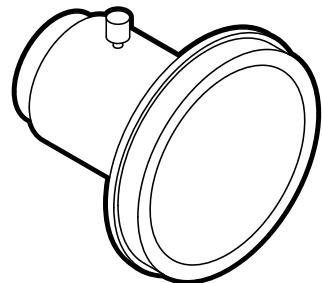
**Wide-Angle Lens**

*with custom focusing barrel*  
(FB360\_V1\_05, \_33)

Sunex DSL318B-650-F2.4

**OPTIONAL:**  
M3 brass jam nuts (14x)

**3x**



**Fisheye Lens**

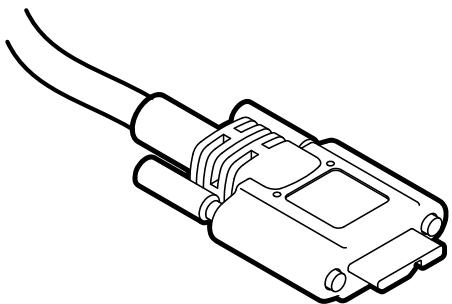
(FB360\_V1\_06)

Fujinon FE185C086HA-1

## 2.

### Wiring

**17x**

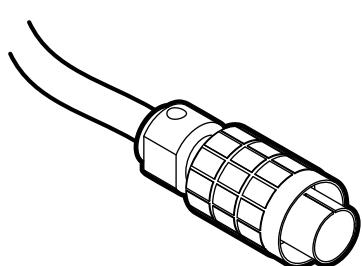


**USB Cable**

Type A to Micro-B

**OPTIONAL:**  
M2 thread, 0.4mm pitch, 20mm long  
replacement screw

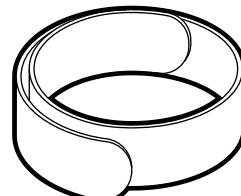
**17x**



**GPIO Cable**

(FB360\_V1\_05, \_33)

Hirose HR25 circular connector, 8 pins



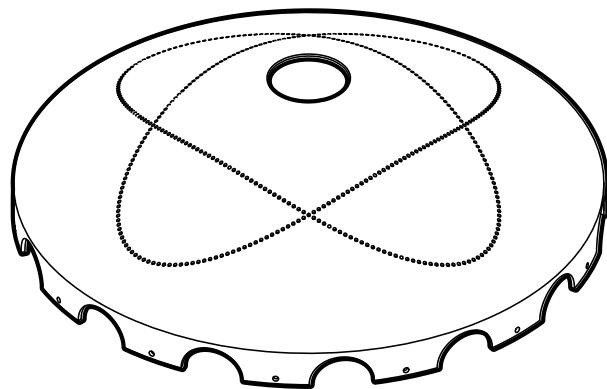
**Velcro Straps**

# 1

## 3.

### Machined Parts

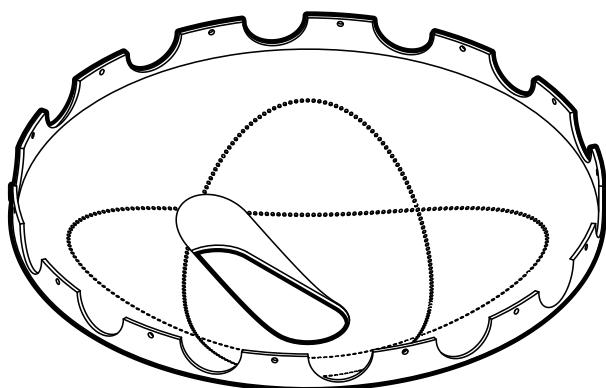
**1x**



**Top Cover**  
(FB360\_V1\_30)

mild steel,  
painted finish

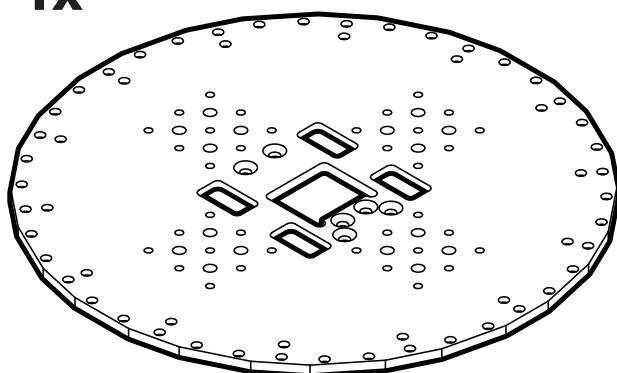
**1x**



**Bottom Cover**  
(FB360\_V1\_29)

mild steel,  
painted finish

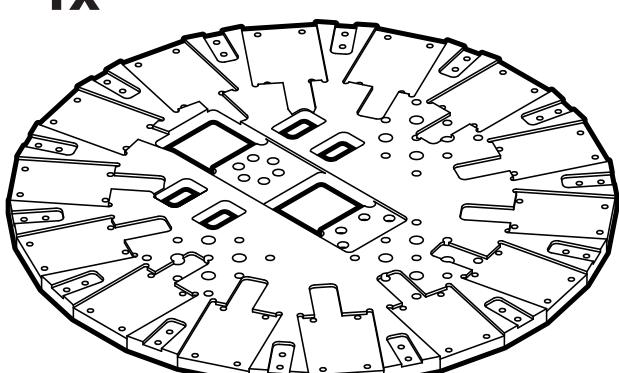
**1x**



**Top Plate**  
(FB360\_V1\_22)

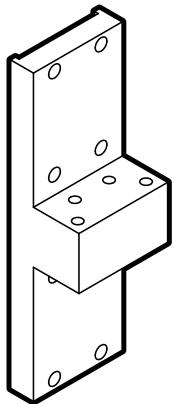
1/4" thick Mic-6 aluminum,  
black anodize finish

**1x**



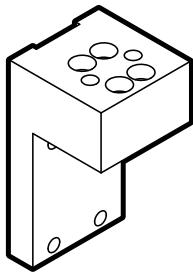
**Base Plate**  
(FB360\_V1\_21)

3/8" thick Mic-6 aluminum,  
black anodize finish

**1****4.****Machined Parts****1x**

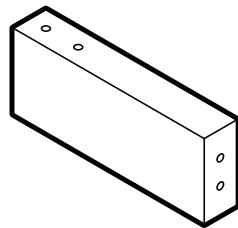
**Upright**  
(FB360\_V1\_23)

6061 aluminum,  
black anodize finish

**1x**

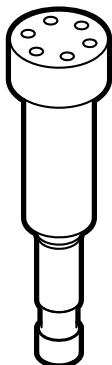
**Camera Bracket**  
(FB360\_V1\_24)

6061 aluminum,  
black anodize finish

**14x**

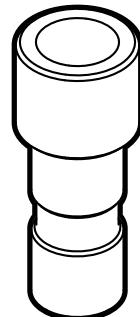
**Shell Support**  
(FB360\_V1\_28)

6061 aluminum,  
black anodize finish

**1x****1x****1x**

**Post**  
(FB360\_V1\_25)

1144 carbon steel,  
black oxide finish



**Adapter**  
(FB360\_V1\_27)

1144 carbon steel,  
black oxide finish

**1x**

**Stop Nut**  
(FB360\_V1\_31)

Brass

**Support Tube**  
(FB360\_V1\_26)

4130 CR tubing,  
black oxide finish

# 1

## 5. Hardware

**152x**



**M3 Socket-Head Cap Screw**

Type 18-8 stainless steel  
M3 thread, 6mm length,  
0.5mm pitch

**152x**



**M3 Belleville Spring Lock Washer**

Type 18-8 stainless steel  
M3 screw size

**28x**



**M3 Flanged Button-Head Socket Cap Screw**

Black-oxide,  
M3 thread, 10mm length,  
0.5mm pitch

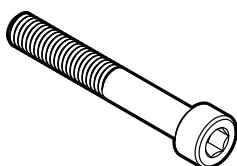
**8x**



**M6 Flat-Head Screw**

Type 18-8 stainless steel  
M6 thread, 12mm length,  
1.0mm pitch

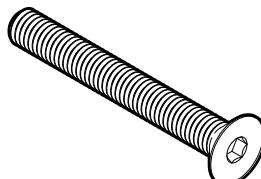
**2x**



**M6 Socket-Head Cap Screw**

Type 18-8 stainless steel  
M6 thread, 40mm length,  
1.0mm pitch

**4x**



**M6 Flat-Head Screw**

Type 18-8 stainless steel  
M6 thread, 50mm length,  
1.0mm pitch

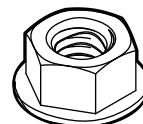
**16x**



**M6 Belleville Spring Lock Washer**

Type 18-8 stainless steel  
M6 screw size

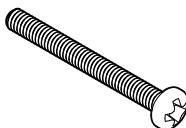
**1x**



**Steel Rotating Flanged Nut**

Black-oxide steel,  
5/16"-18 thread size  
3/4" flange diameter  
7/16" overall height

## Optional



**M2 Socket-Head Cap Screw**

Type 18-8 stainless steel  
M2 thread, 20mm length,  
0.4mm pitch

(replace USB locking screws)



**M3 Jam Nut**

Brass, M3 thread size,  
5.5mm Wide, 1.8mm  
High  
(lock nut for Sunex barrel)

**1x**

**Steel Threaded Rod (FB360\_V1\_32)**

ASTM A193 grade B7 steel  
5/16"-18 thread  
20-1/4" long  
fully threaded

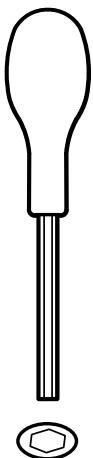


# 1

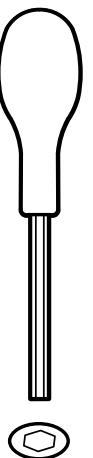
## 6. Tools

### Hand Tools

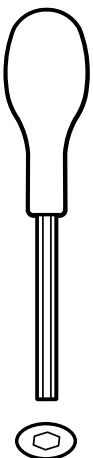
5mm  
HEX



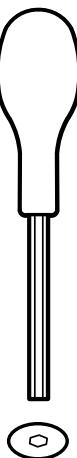
4mm  
HEX



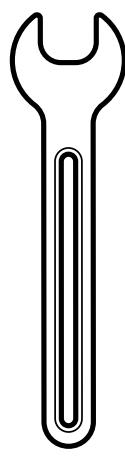
2.5mm  
HEX



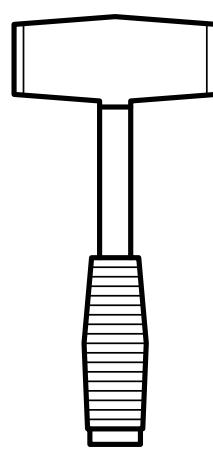
2mm  
HEX



9/16"  
Wrench

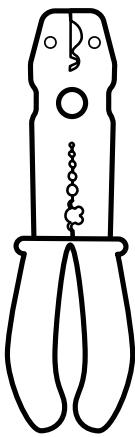


Rubber  
Mallet

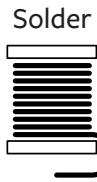
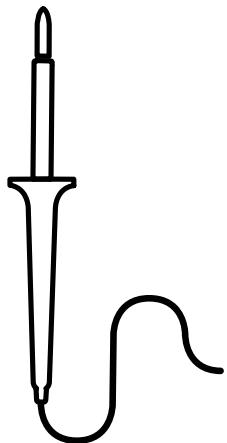


### Wiring Tools

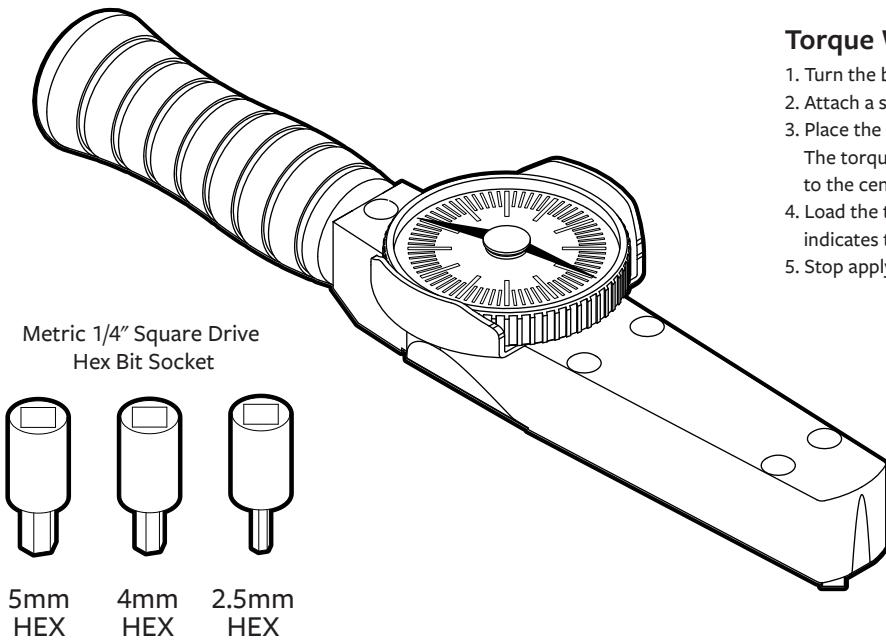
Wire  
Cutter



Soldering  
Iron



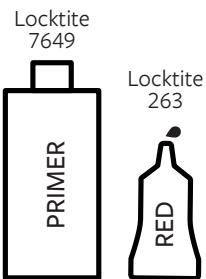
## Torque Wrench



### Torque Wrench Instructions:

1. Turn the bezel until pointer is resting on zero.
2. Attach a socket or attachment to the square drive.
3. Place the socket or attachment over the fastener to be torqued. The torque wrench handle must be perpendicular (90 degrees) to the centerline of the drive, socket and fastener.
4. Load the torque wrench at a slow and steady rate until the pointer indicates the desired torque.
5. Stop applying force. The pointer should return to zero.

## Threadlockers & Adhesive



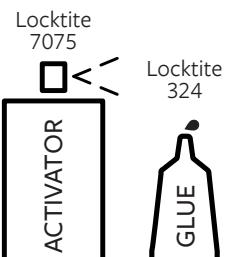
Permanent Threadlocker



Removable Threadlocker

### Threadlocker Instructions:

1. Apply primer to surface of bolt and nut.
2. Apply several drops of the threadlocker onto the bolt at the nut engagement area.
3. Assemble parts and tighten as required. Sets in approximately 10 minutes and fully cures in 24 hours.



Cyanoacrylate Adhesive

### Adhesive Instructions:

1. Apply the surface activator to both surfaces.
2. Wait 20 seconds for the activator to completely dry.
3. Apply glue sparingly to one side only using approximately one drop per square inch of surface.
4. Press parts together immediately.
5. Hold in place for 30 seconds or until bond sets.

# 1

## 8.

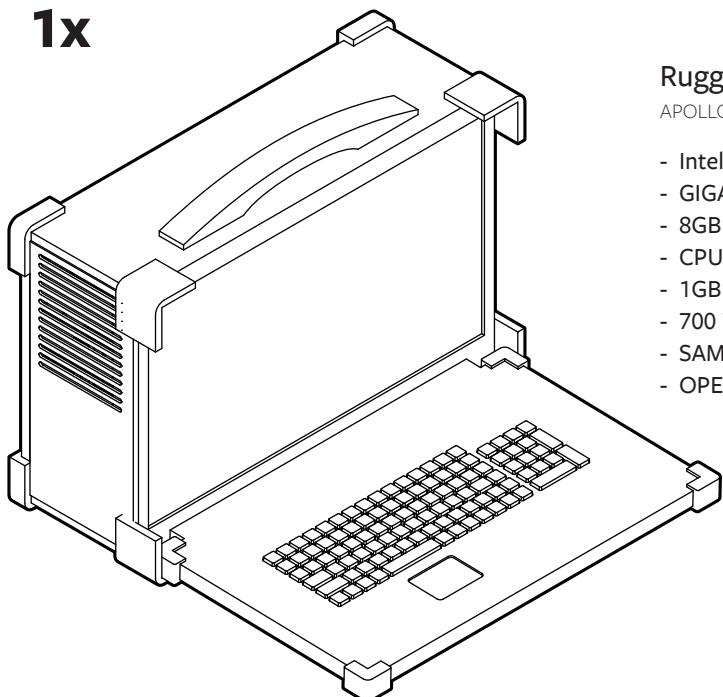
### Computer Hardware



#### Assembly Note

See system setup instructions for details

**1x**

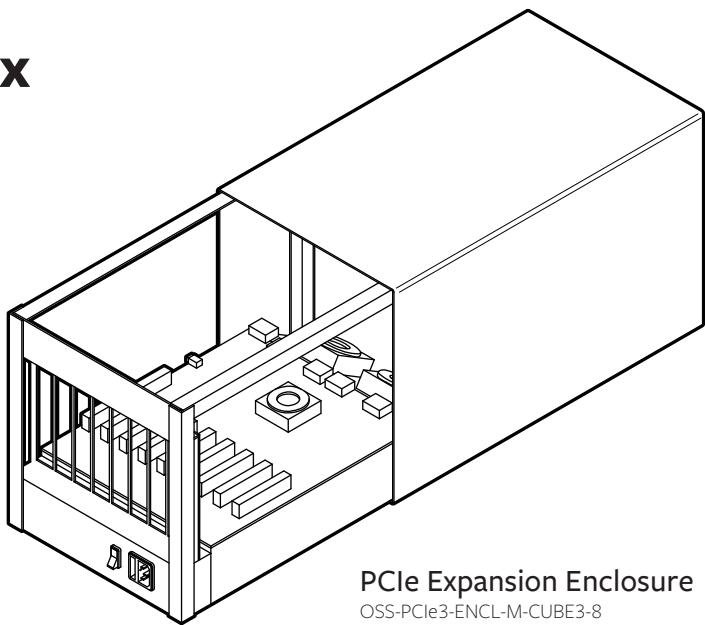


Ruggedized "Lunchbox" Computer

APOLLO-A1 MODEL

- Intel Core i7-5960X Haswell-E 8-Core 3.0 GHz LGA 2011-v3
- GIGABYTE GA-X99P-SLI (rev. 1.0) LGA 2011-v3 Intel X99 Motherboard
- 8GB DDR4 2400 288-PIN Memory = (64GB of Memory Installed)
- CPU COOLING FAN FOR LGA 2011-v3
- 1GB NVIDIA PCI-EX16 VIDEO CARD
- 700 WATT POWER SUPPLY
- SAMSUNG 850 Pro Series 2.5" 128GB SSD
- OPERATING SYSTEM - UBUNTU 14.04 LTS

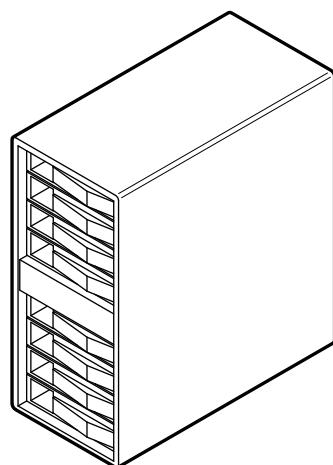
**1x**



PCIe Expansion Enclosure

OSS-PCIe3-ENCL-M-CUBE3-8

**1x**



8-bay 12G SAS RAID Tower

ARC-4038

Expansion Backplane

OSS-BP-452

# 1

## 9.

### Computer Hardware



#### Assembly Note

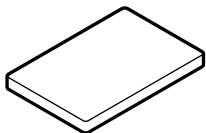
See system setup instructions for details

**1x**



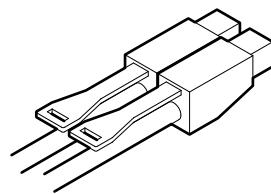
Shunt  
Jumper  
390088-1

**8x**



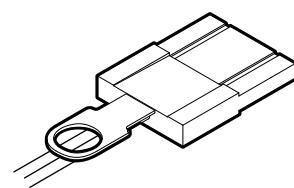
1TB SSD  
MZ 7KE1TOBW

**2x**



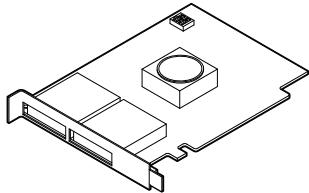
External 4x HD Mini-SAS Cable  
SFF-8644 to SFF-8644

**1x**



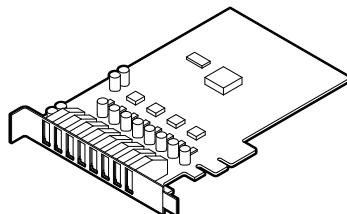
PCIe x8 Active Optical Cable  
OSS-PCIe3-CBL-ACT-x8-50M-1x

**2x**



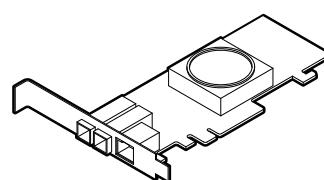
PCIe x8 Gen 3 Cable Adapter  
OSS-PCIe-HIB38-x8-DUAL

**5x**



USB 3.0 Expansion Card  
UE-1008 or UE-1004

**1x**



PCIe 3.0 x8 SAS RAID Adapter  
ARC-1883X

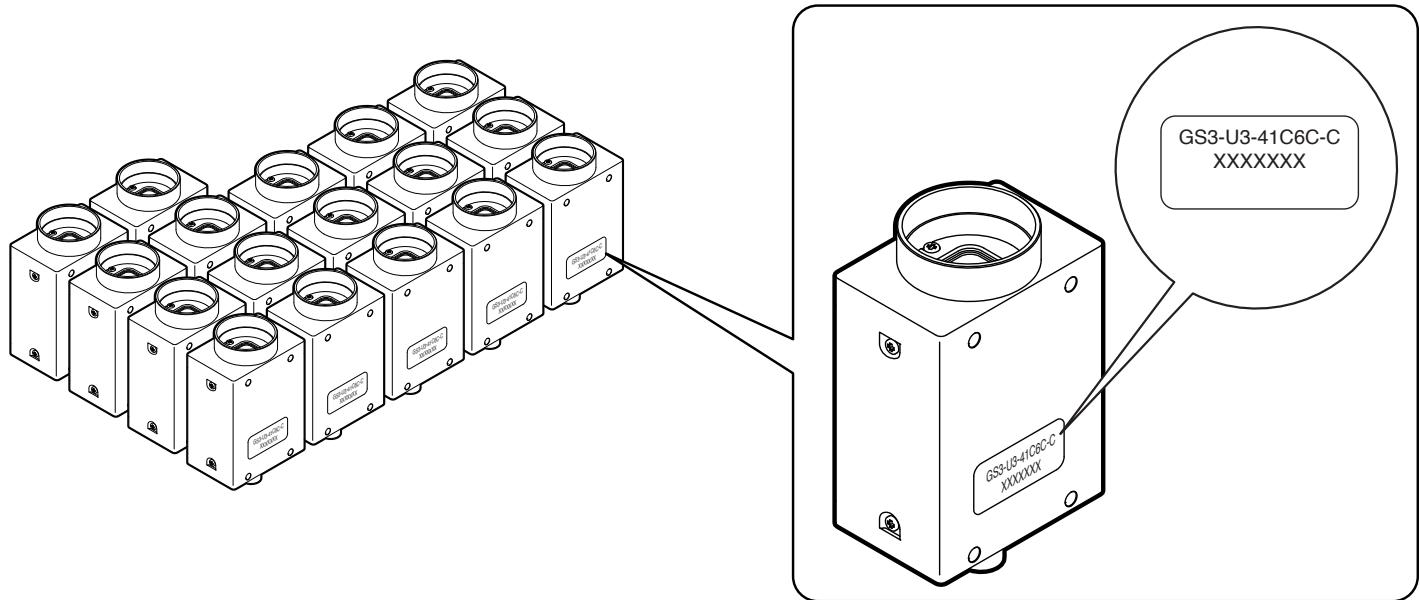
# 2

**Before You Start**

# 2

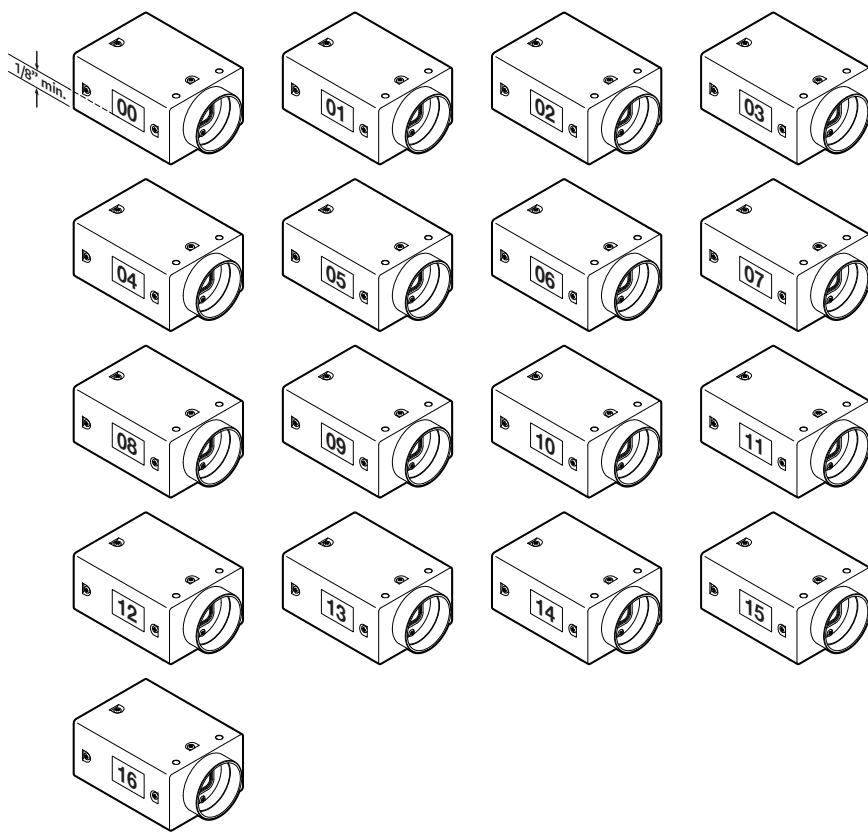
## 1.

Arrange Cameras in Ascending Sequential Order (Per Serial Number)



## 2.

Label Cameras # 00 - 16



**Tip:**

Keep labels 1/8" min. away  
from bottom of camera to clear  
mounting plate

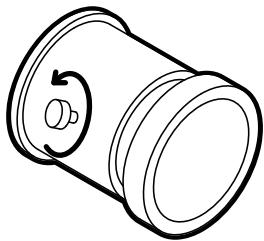
# 2

## 3.

### Replace Focusing Barrel of Wide-Angle Lenses (# 01 - 14)

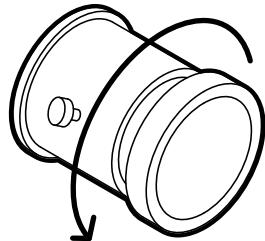
#### Step 1:

Remove thumb screw



#### Step 2:

Remove existing barrel  
and internal spring  
(counterclockwise)



#### Step 3:

Screw on new focusing barrel\* clockwise  
and tighten thumb screw

#### Step 4 (Optional):

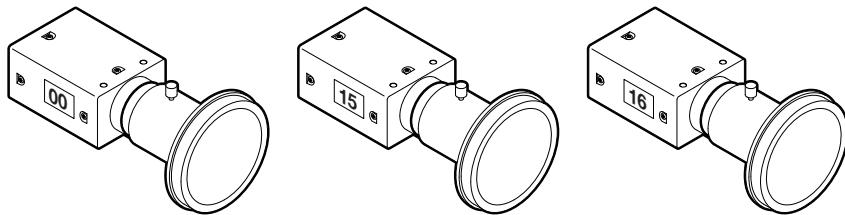
Tighten optional lock nuts (M3 brass jam nuts)

\* Refer to DWG FB360\_V1\_33

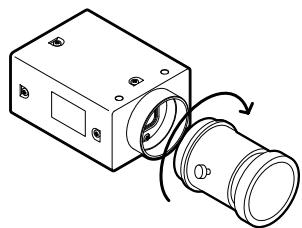
## 4.

### Mount Lenses

#### Fujinon Fisheye - # 00, 15, 16

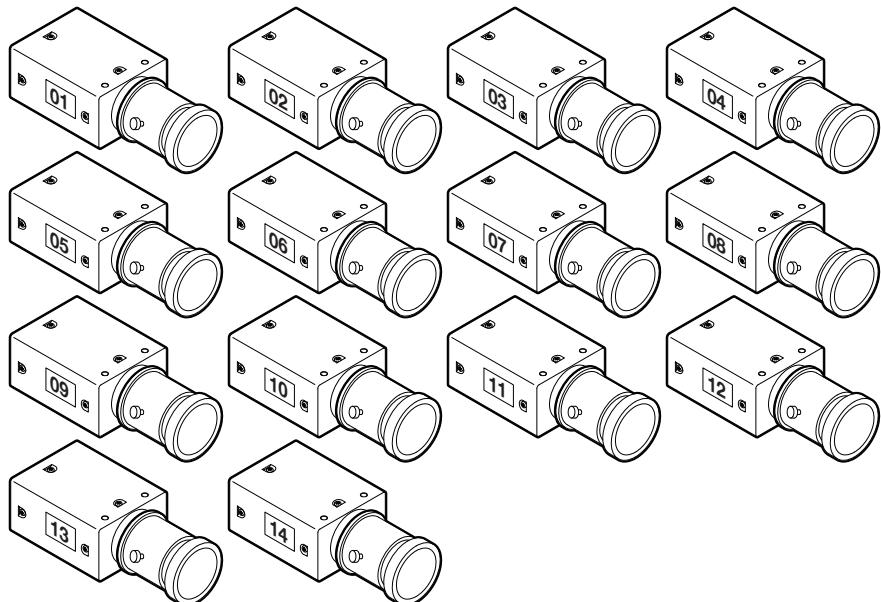


#### Sunex Wide-Angle - # 01 - 14



#### Tip:

Screw lens onto camera  
clockwise till its snudge



# 2

## 5.

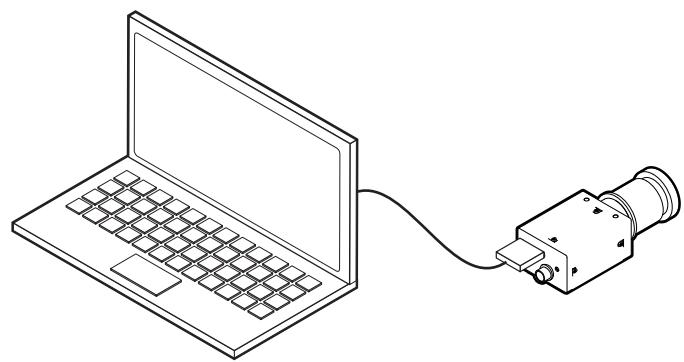
### Firmware Update

**Step 1:**

Download firmware for Grasshopper3 (GS3-U3-41C6C-C)  
<https://www.ptgrey.com/support/downloads>

**Step 2:**

Follow instructions to update firmware for cameras



## 6.

### Focusing Lenses

**Step 1:**

Download and install FlyCapture from Point Grey (<https://www.ptgrey.com/support/downloads>)

**Step 2:**

Connect camera (with lens) to PC or Linux computer

**Step 3:**

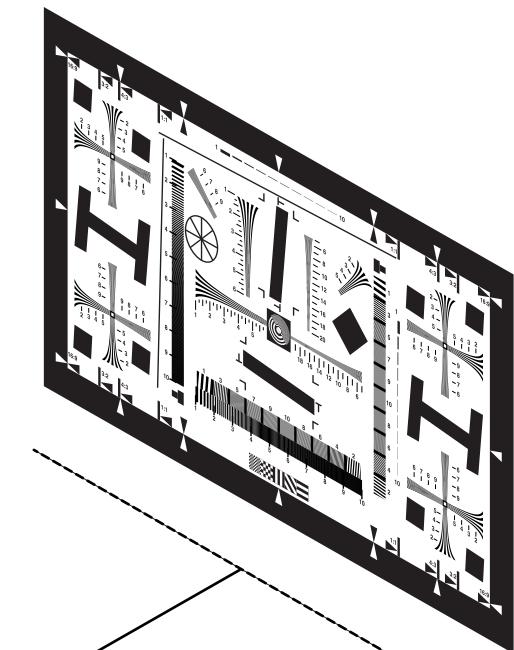
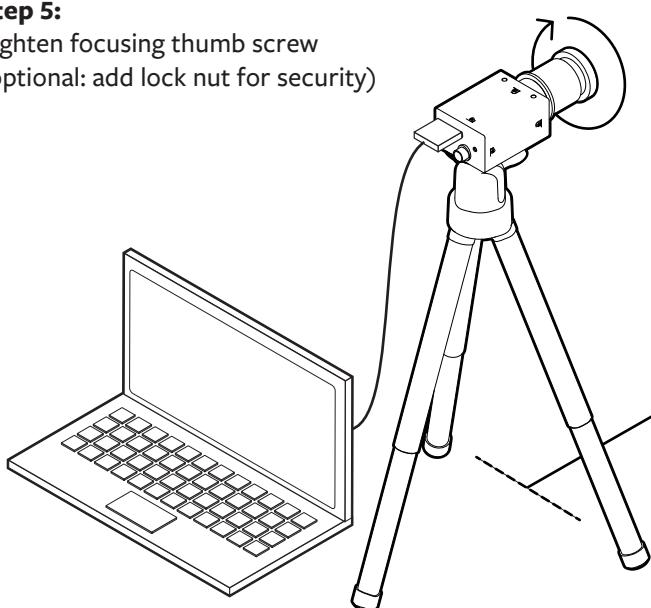
Set camera on tripod about 10 feet away from chart\* on wall

**Step 4:**

Loosen focusing thumb screw on lens and rotate focusing barrel till image in preview pane is sharp. Zoom in when necessary

**Step 5:**

Tighten focusing thumb screw  
(optional: add lock nut for security)



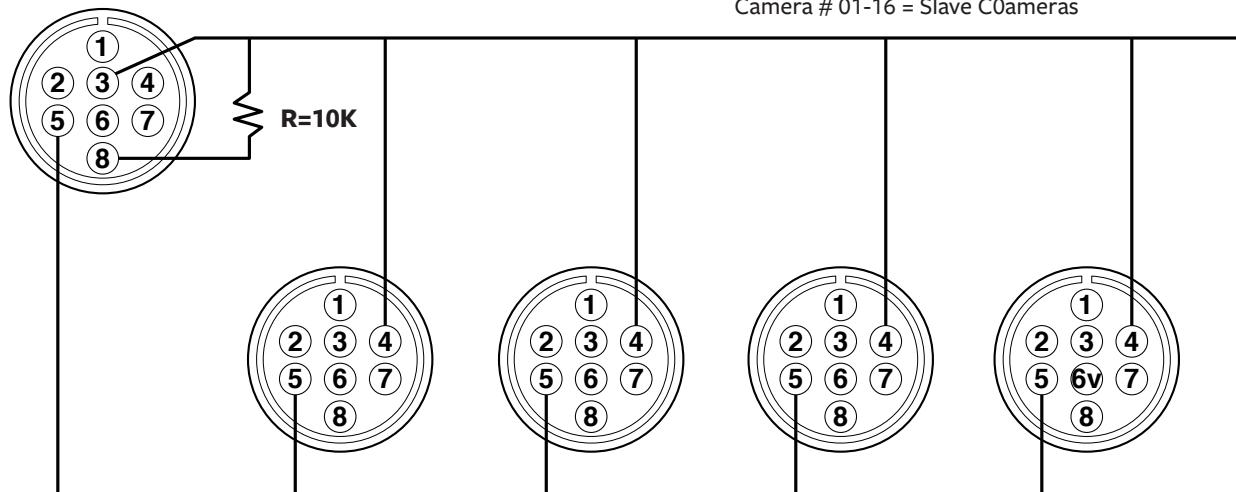
\* Use ISO 12233 chart or equivalent

# 2

## 7. GPIO Trigger Cable

### A - Wiring Diagram

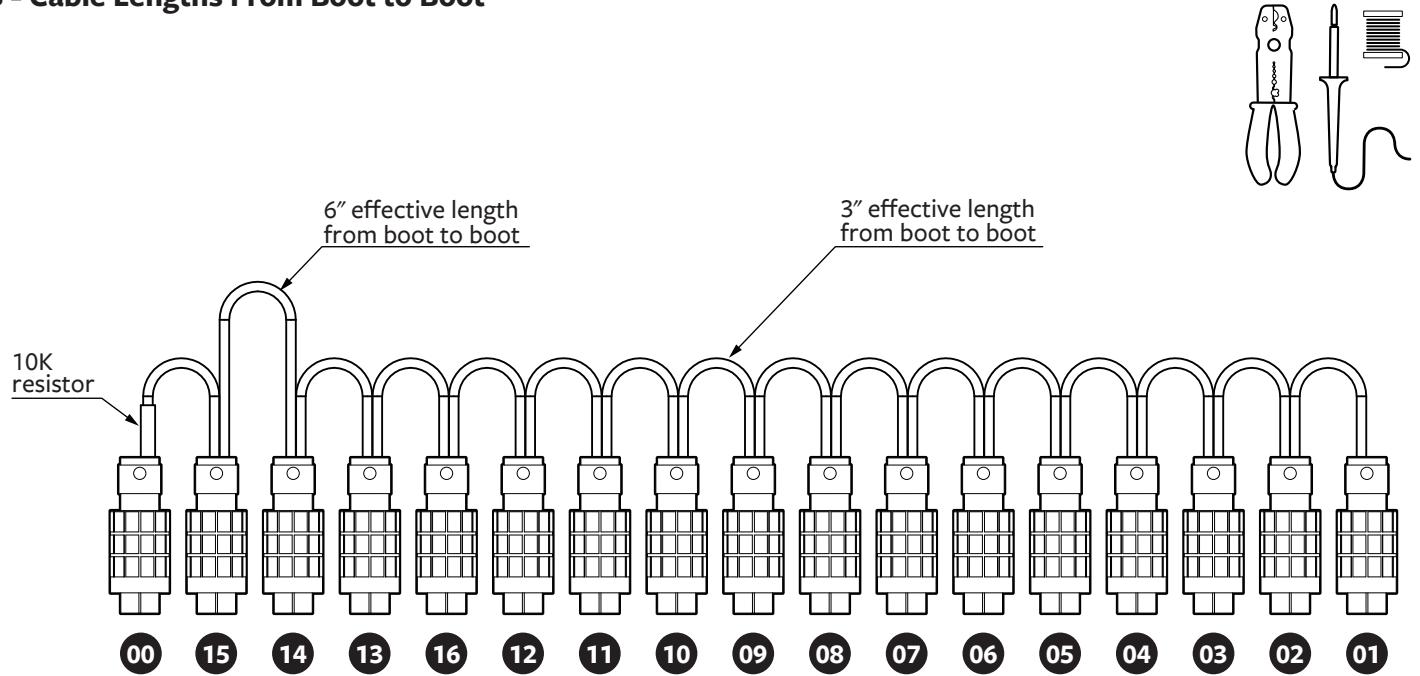
Camera # 00 (Top) = Master Camera  
Camera # 01-16 = Slave Cameras



- PIN ③** IO2 - Input/Output/Serial Transmit (TX)
- PIN ④** IO3 - Input/Output/Serial Receive (RX)
- PIN ⑤** GND - Ground for bi-directional IO, V<sub>EXT</sub>, +3.3V pins
- PIN ⑧** + 3.3V - Power external circuitry up to 150mA

\* Refer to DWG FB360\_V1\_34

### B - Cable Lengths From Boot to Boot



\* Refer to DWG FB360\_V1\_34

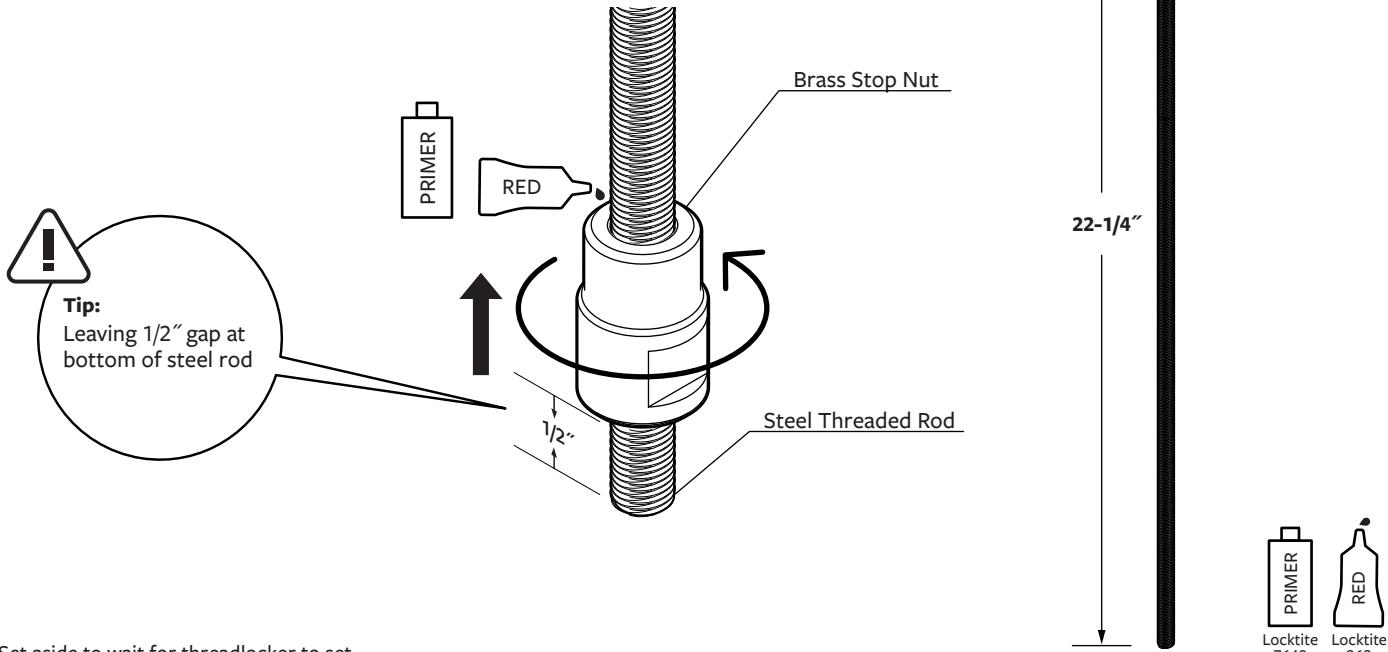
# 3

## **Camera Assembling Instructions**

# 3

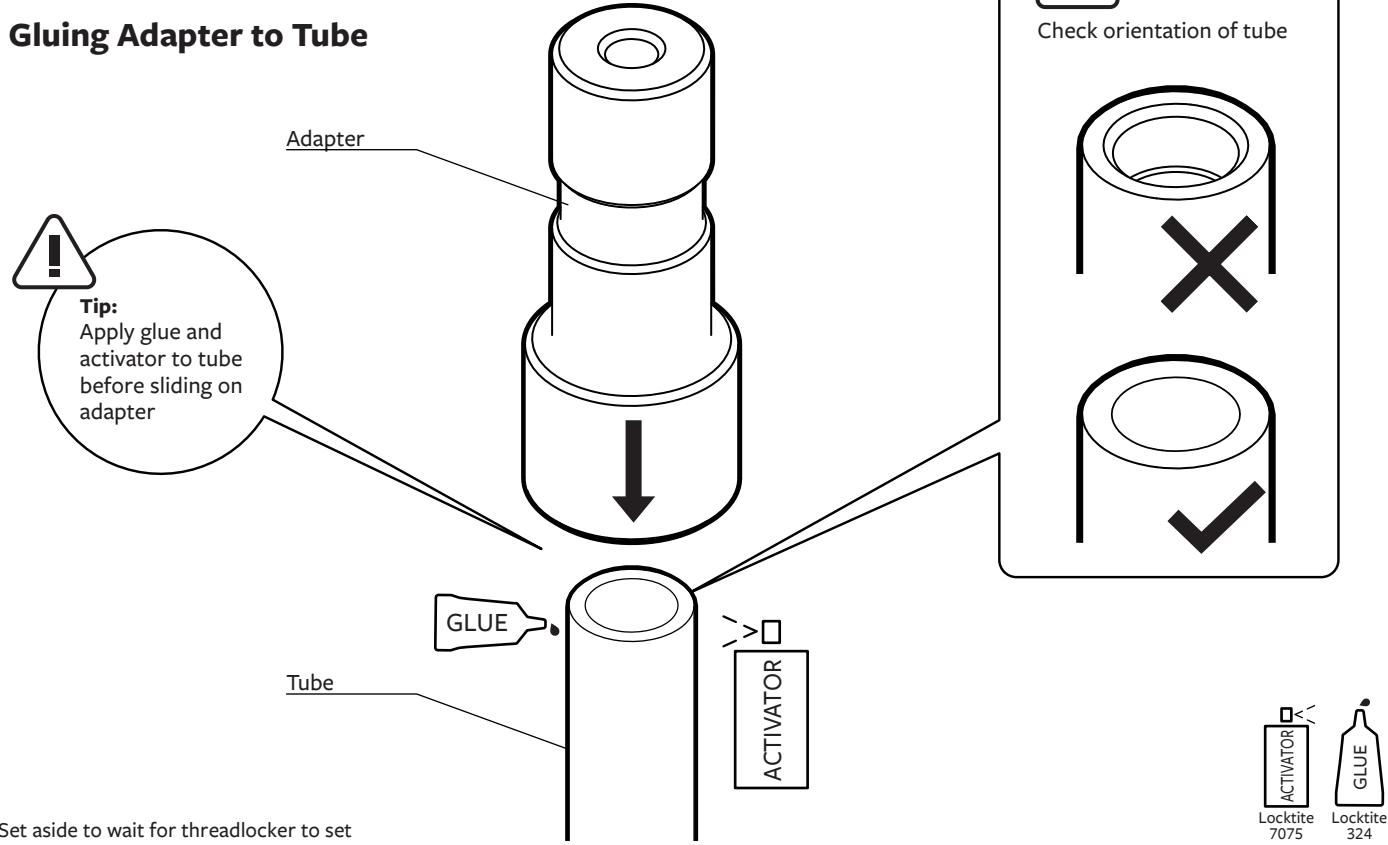
## 1.

### Screw Brass Nut Onto Threaded Rod



## 2.

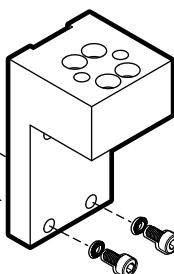
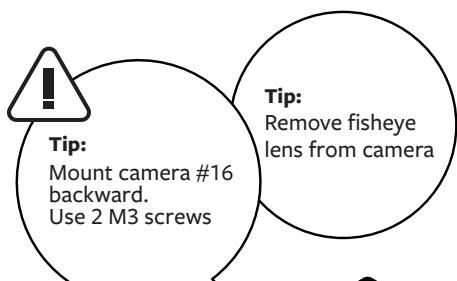
### Gluing Adapter to Tube



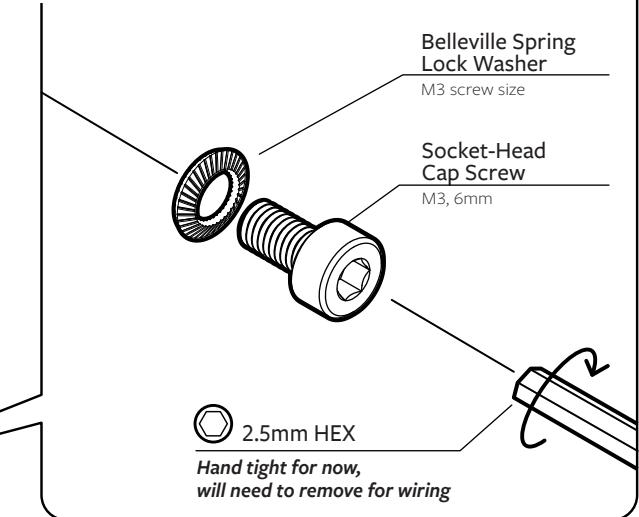
# 3

## 3.

### Bottom Camera (#16) & Camera Bracket

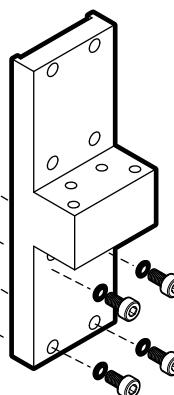
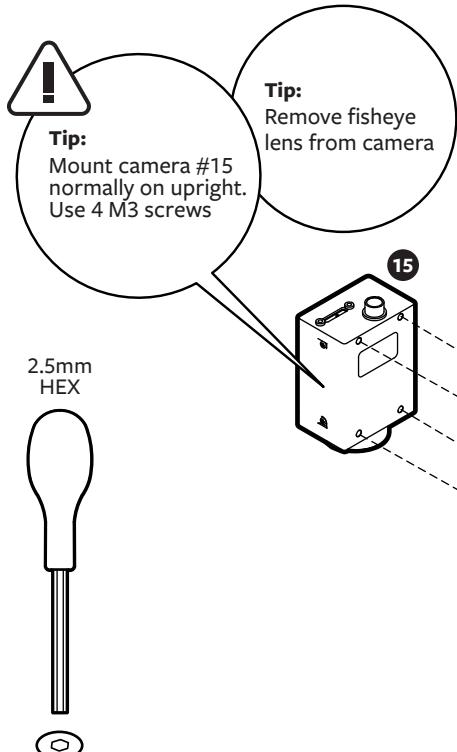


2x

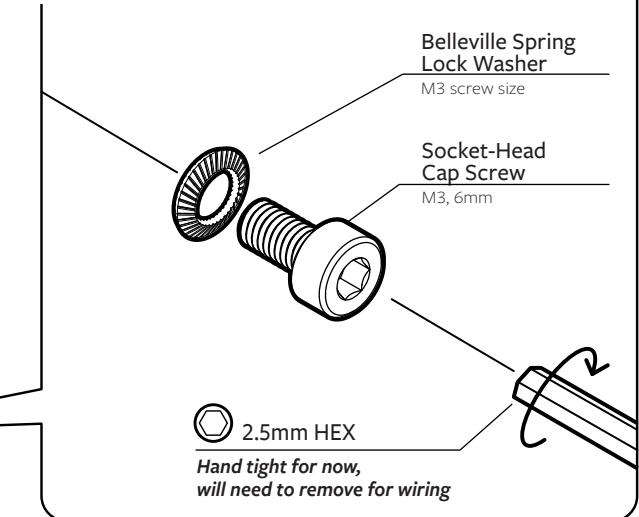


# 4.

### Bottom Camera (#15) & Upright



4x

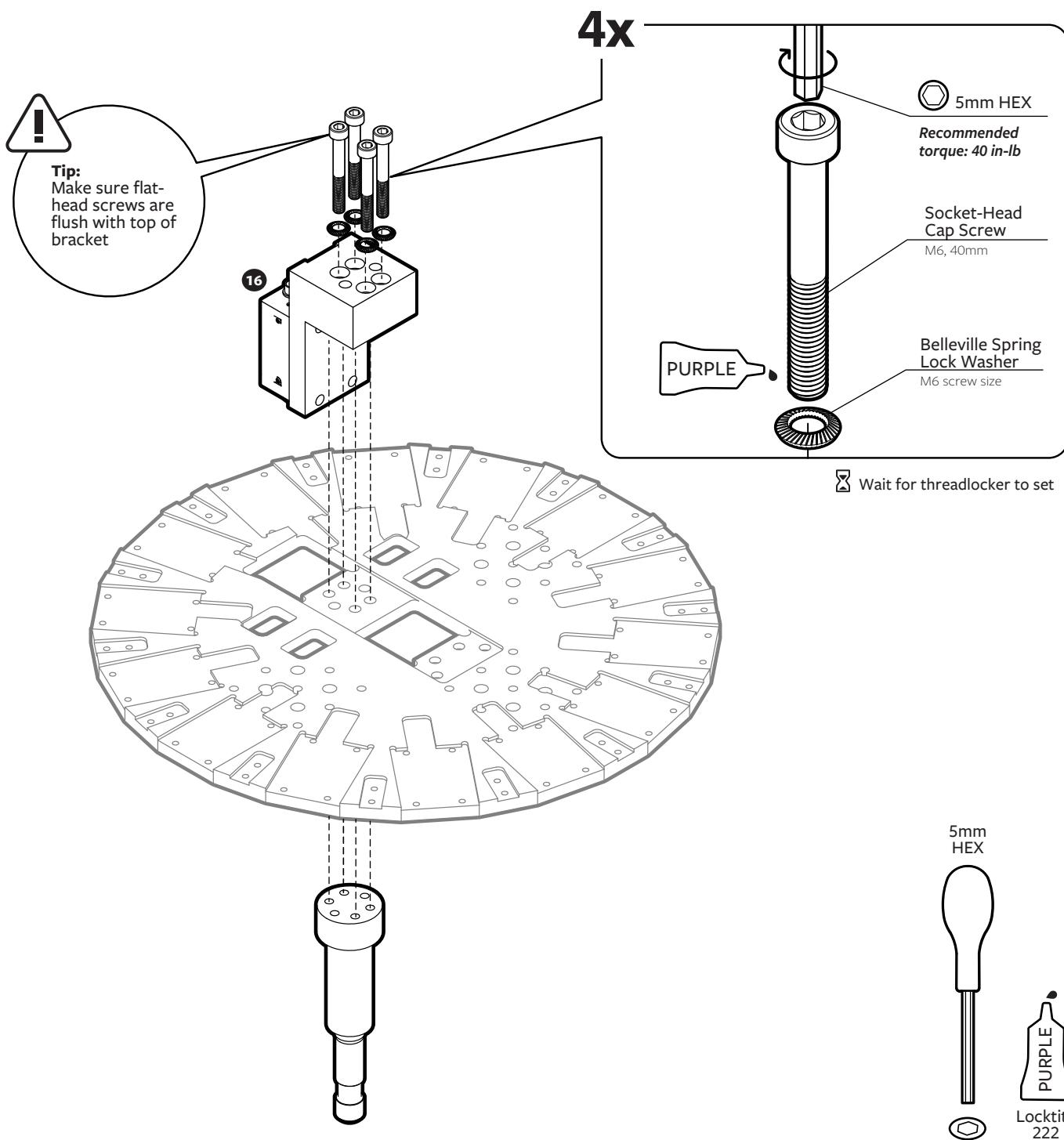
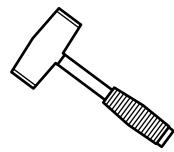


# 3

## 5. Camera Bracket & Post

### Assembly Note

Use a rubber mallet to gently tap upright in place if fitting is too tight

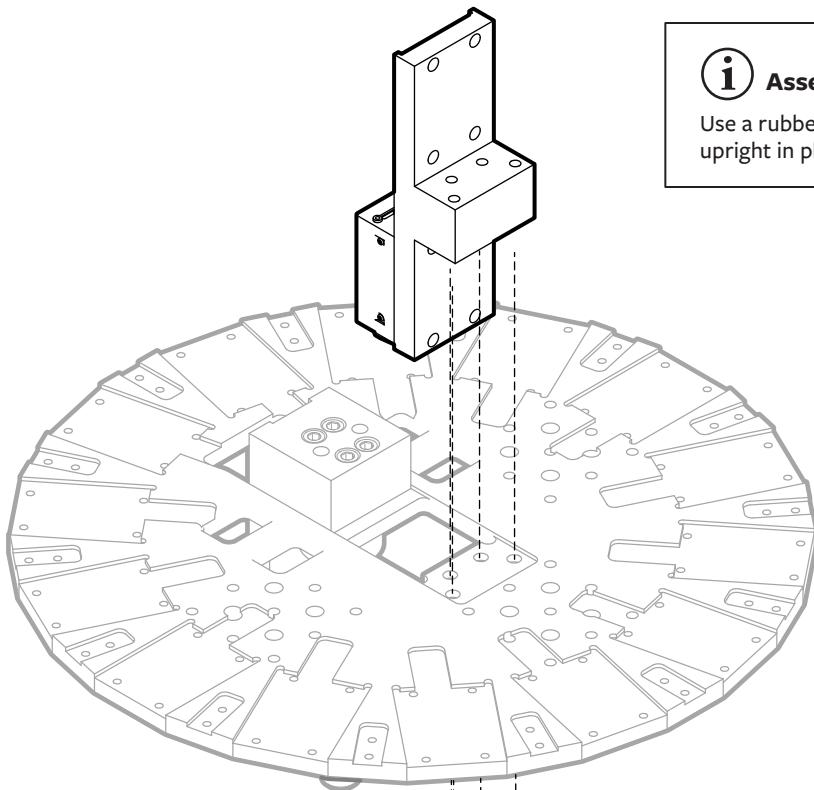


# 3

## 6. Upright

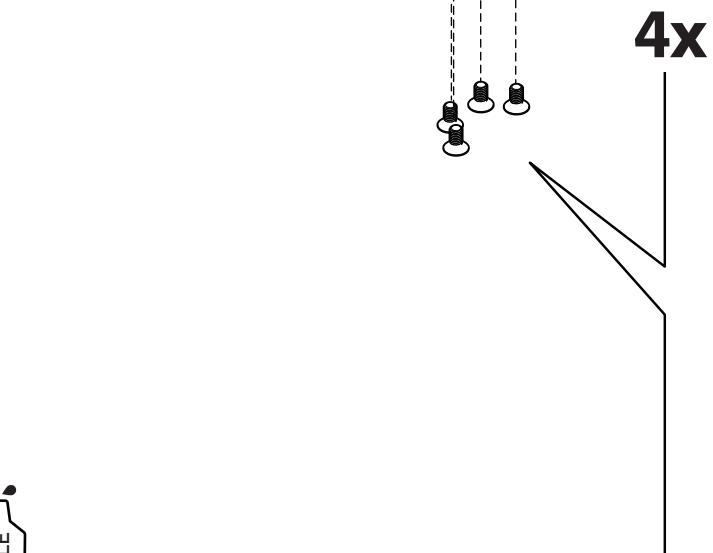
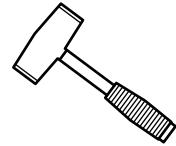


**Assembly Note** 180°  
Flip 180° to tighten screws

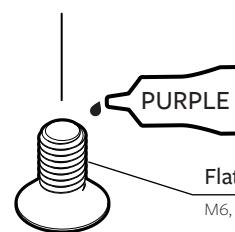


### Assembly Note

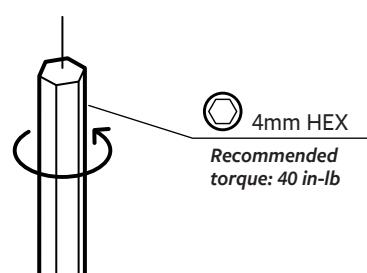
Use a rubber mallet to gently tap upright in place if fitting is too tight



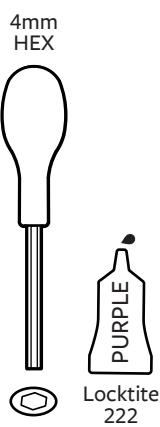
4X



PURPLE  
Flat-Head Screw  
M6, 12mm



4mm HEX  
Recommended  
torque: 40 in-lb



PURPLE  
Locktite  
222

Wait for threadlocker to set

# 3

## 7.

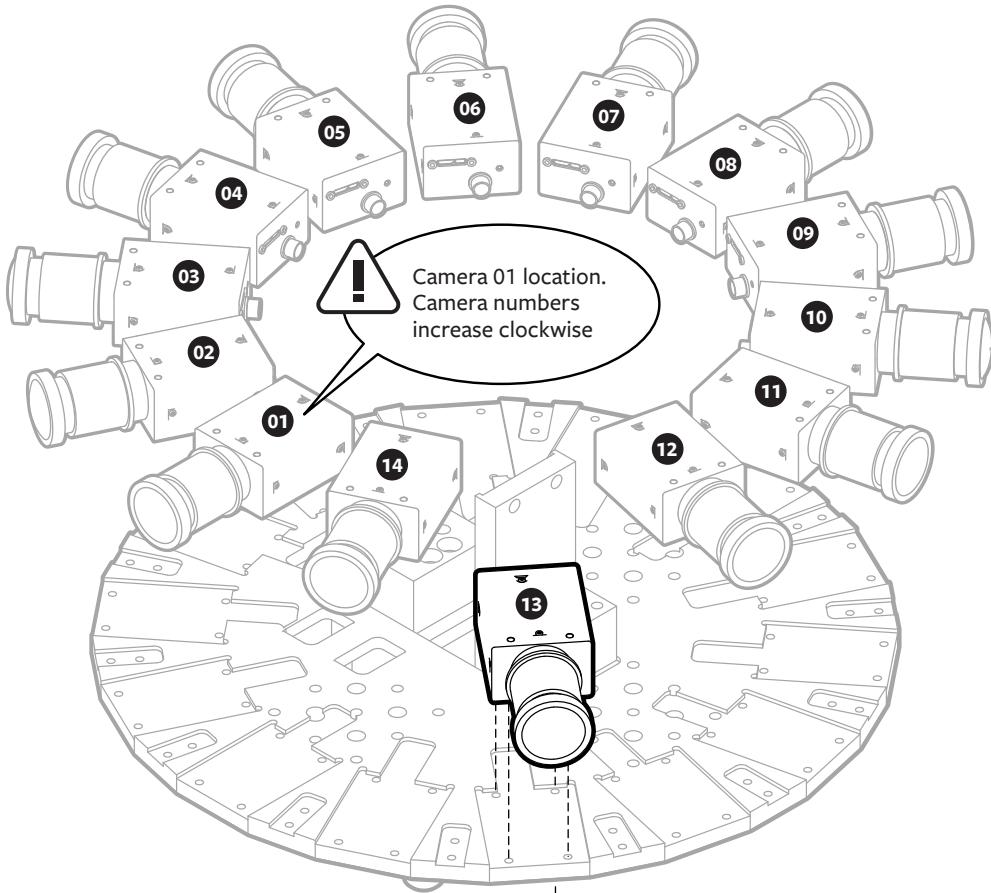
### Side Cameras (Camera #01-14)



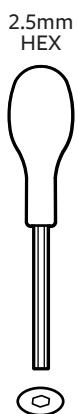
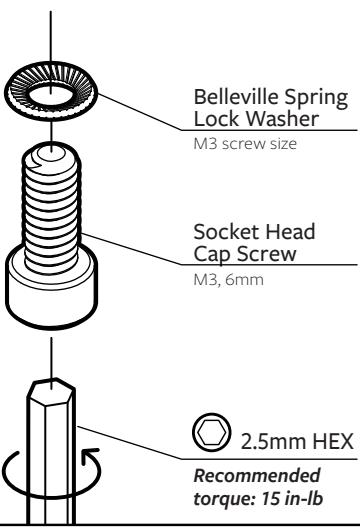
Assembly Note



Flip 180° to tighten screws



56x



# 3

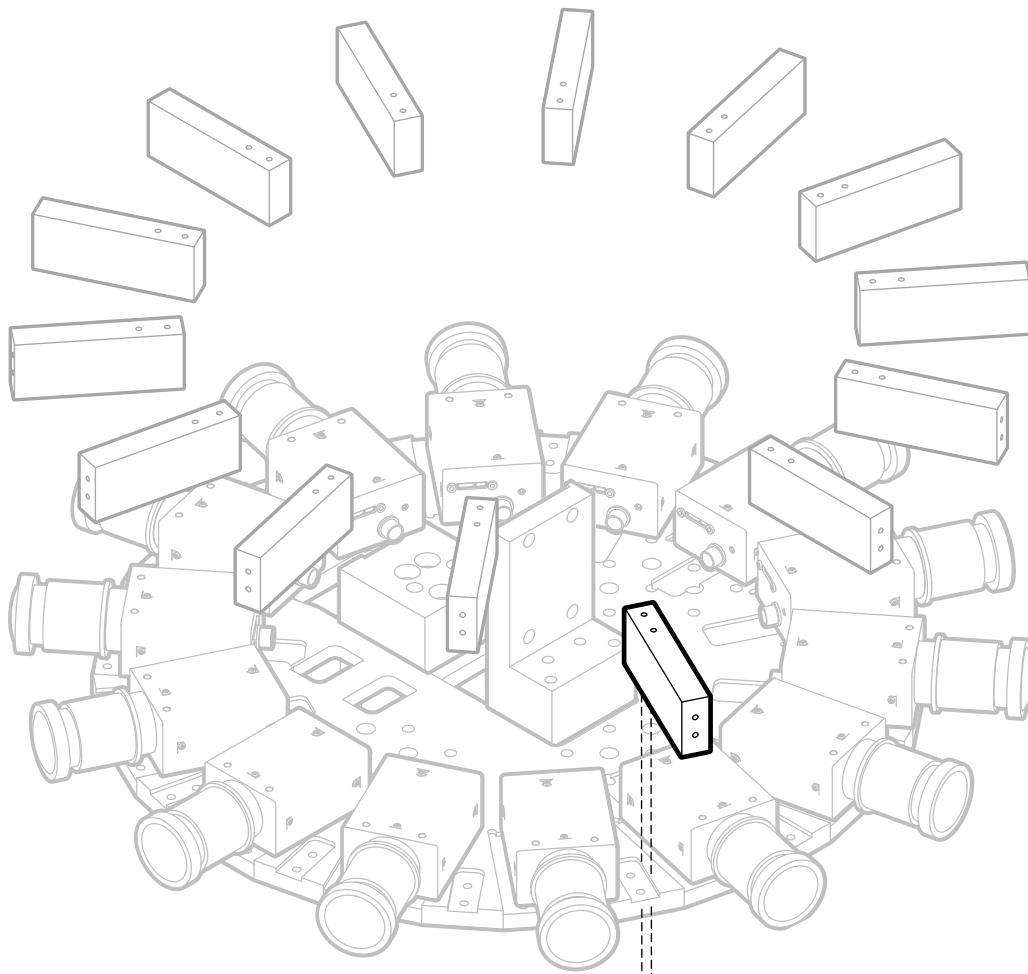
## 8. Blocks



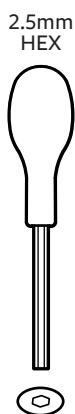
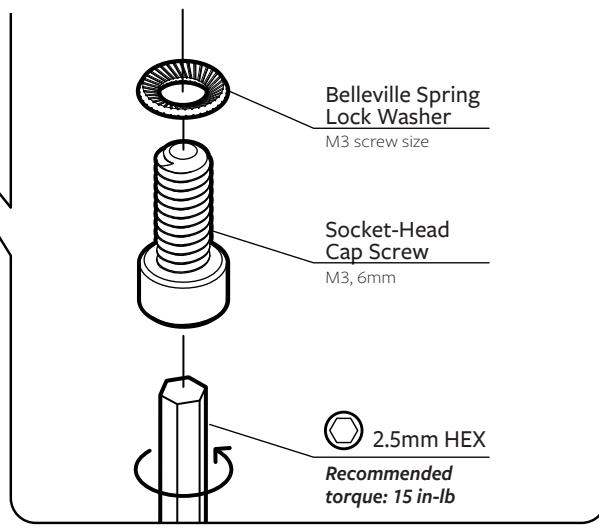
Assembly Note



Flip 180° to tighten screws



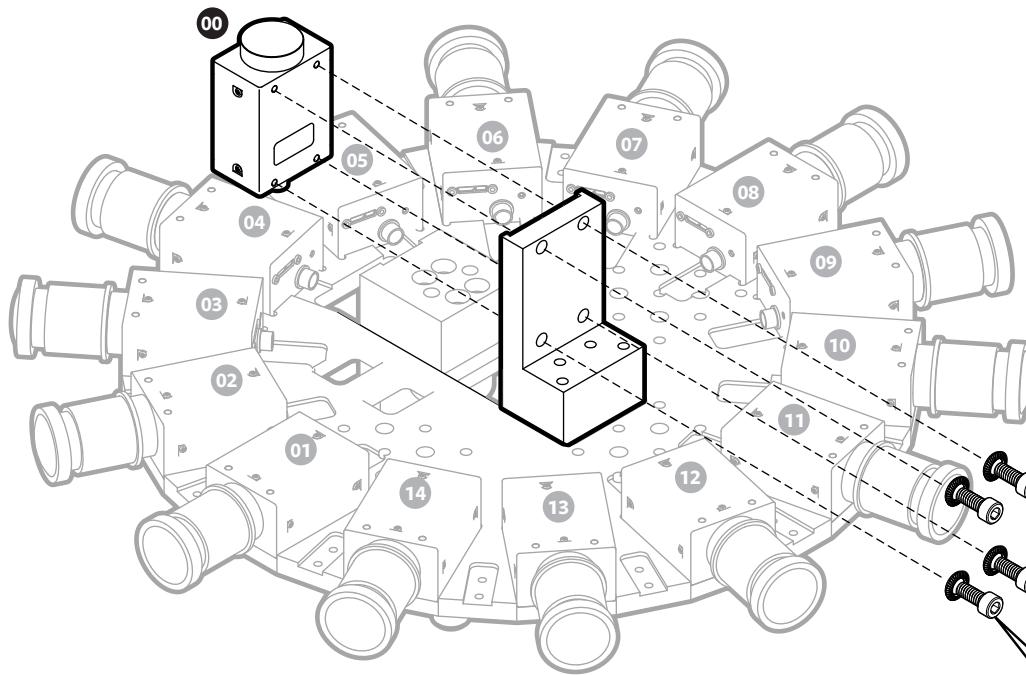
28x



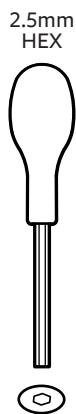
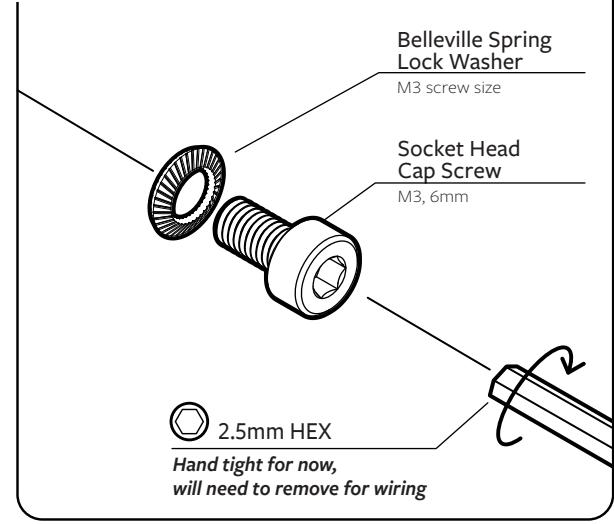
# 3

## 9.

### Top Camera (Camera #00)



4x



# 3

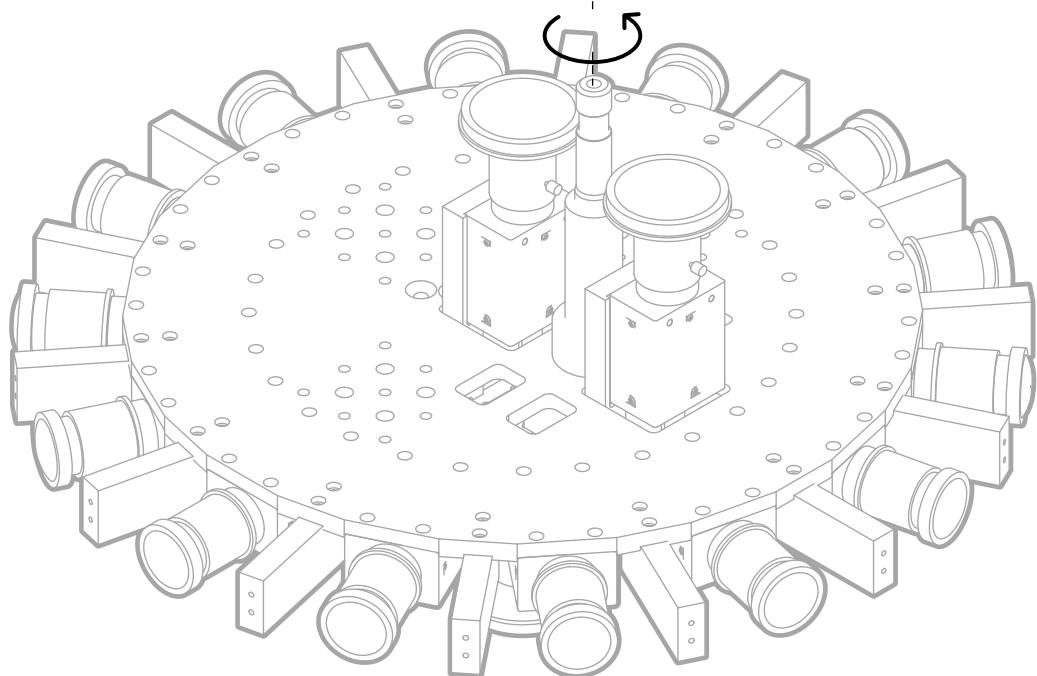
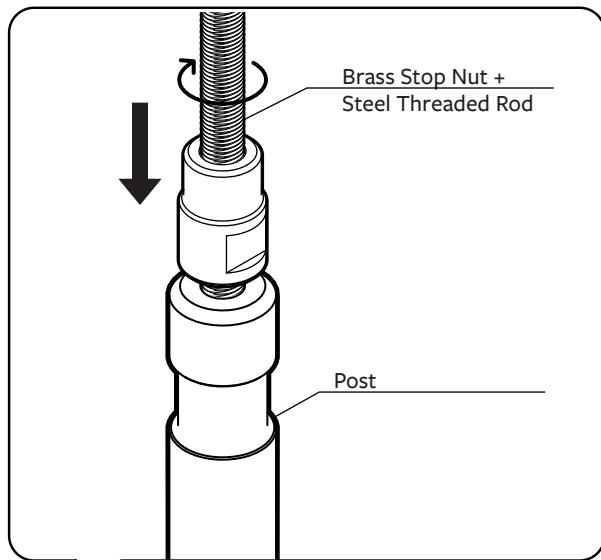
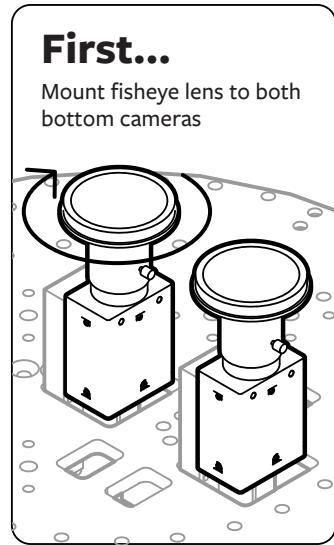
## 10.

### Threaded Rod & Stop Nut



Assembly Note  
Flip 180° for this step

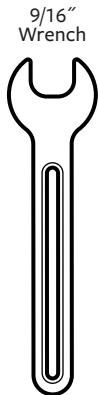
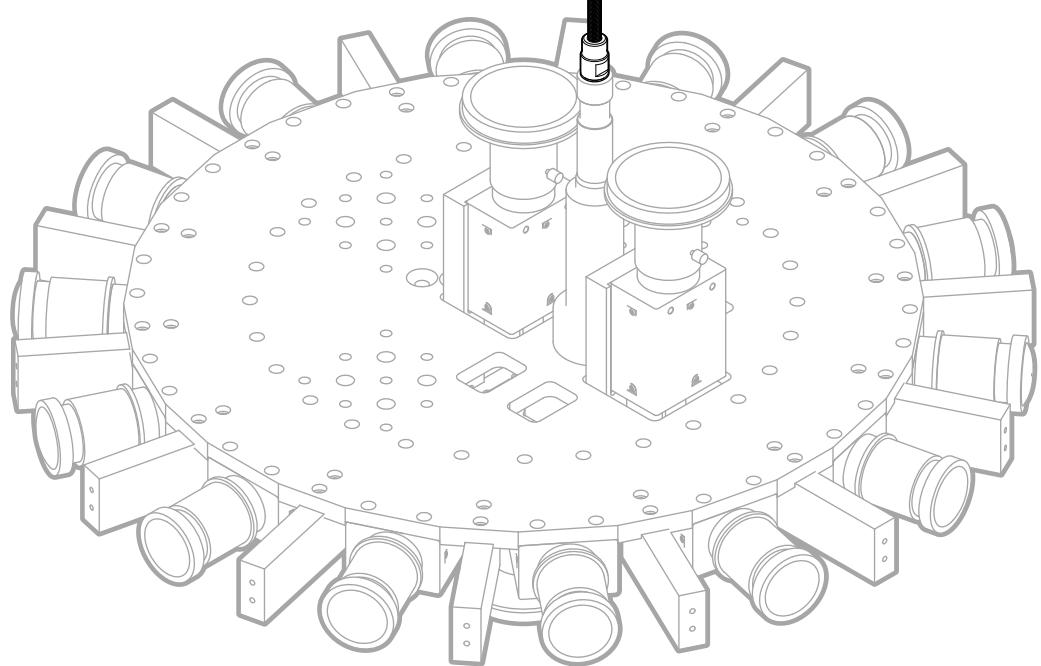
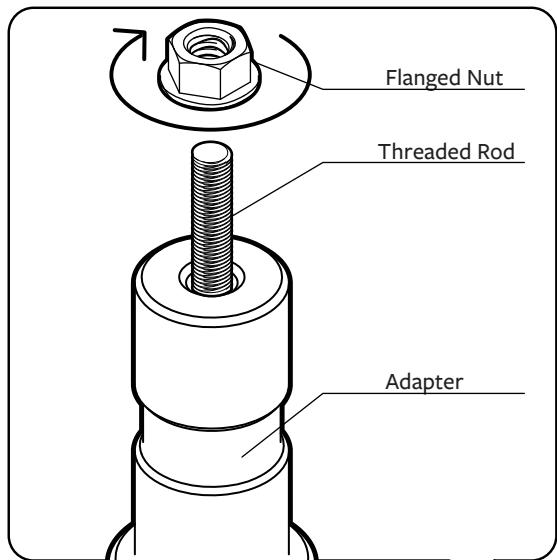
180°



# 3

## 11. Tube & Adapter

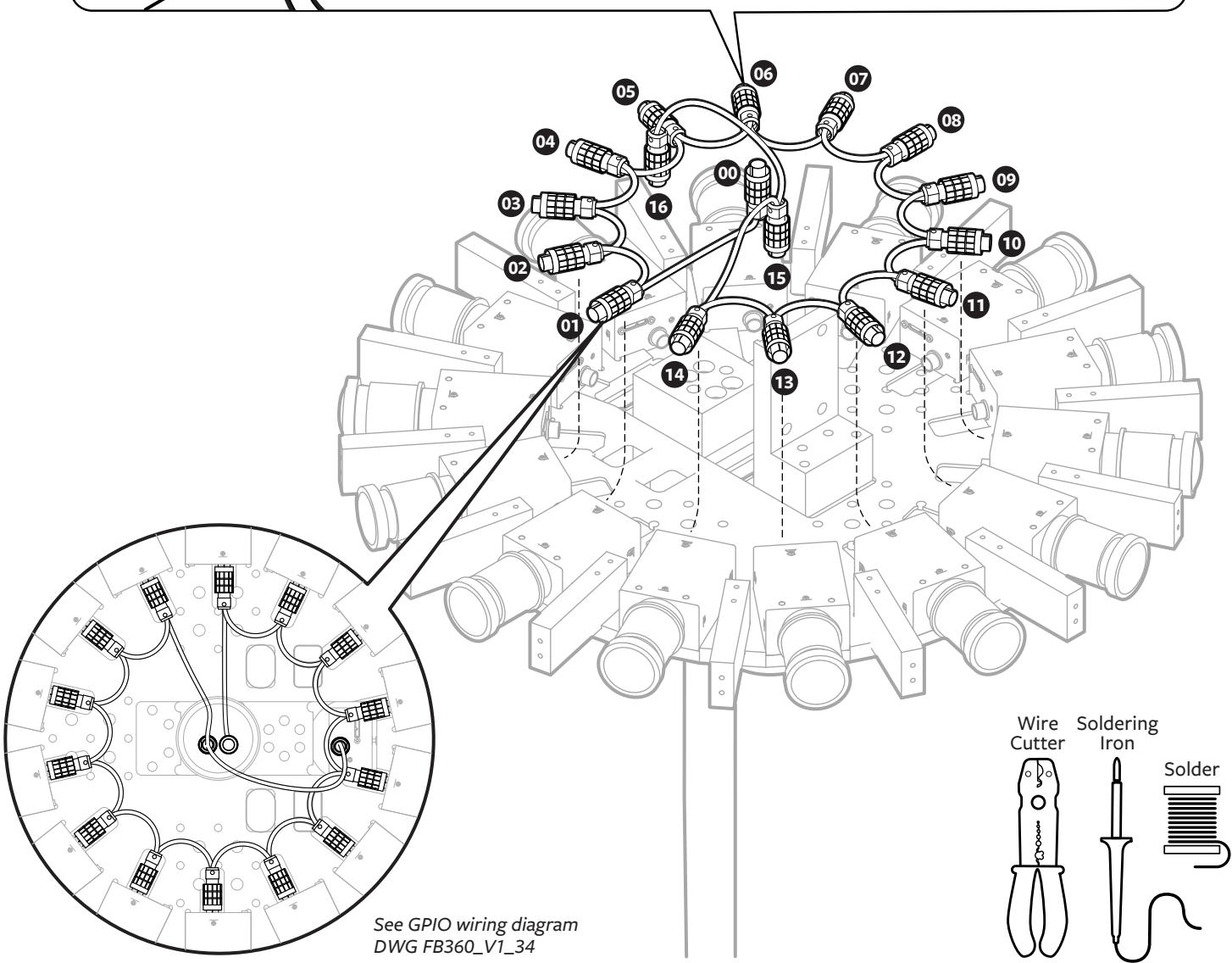
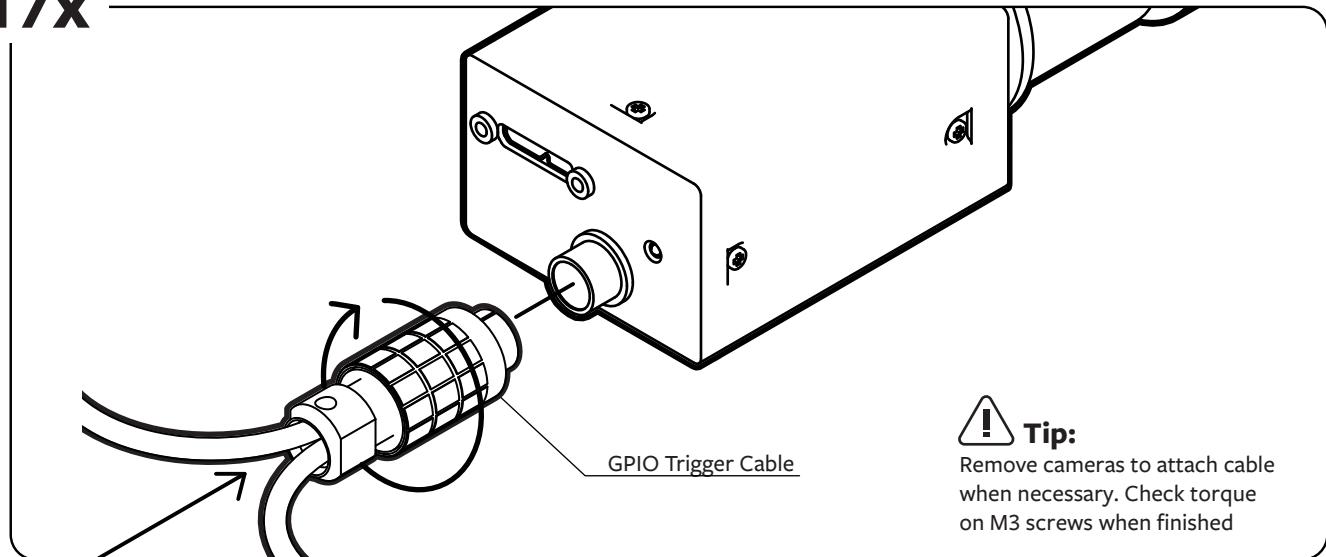
Assembly Note  180°  
Flip 180° for this step



# 3

## 12. GPIO Trigger Cable

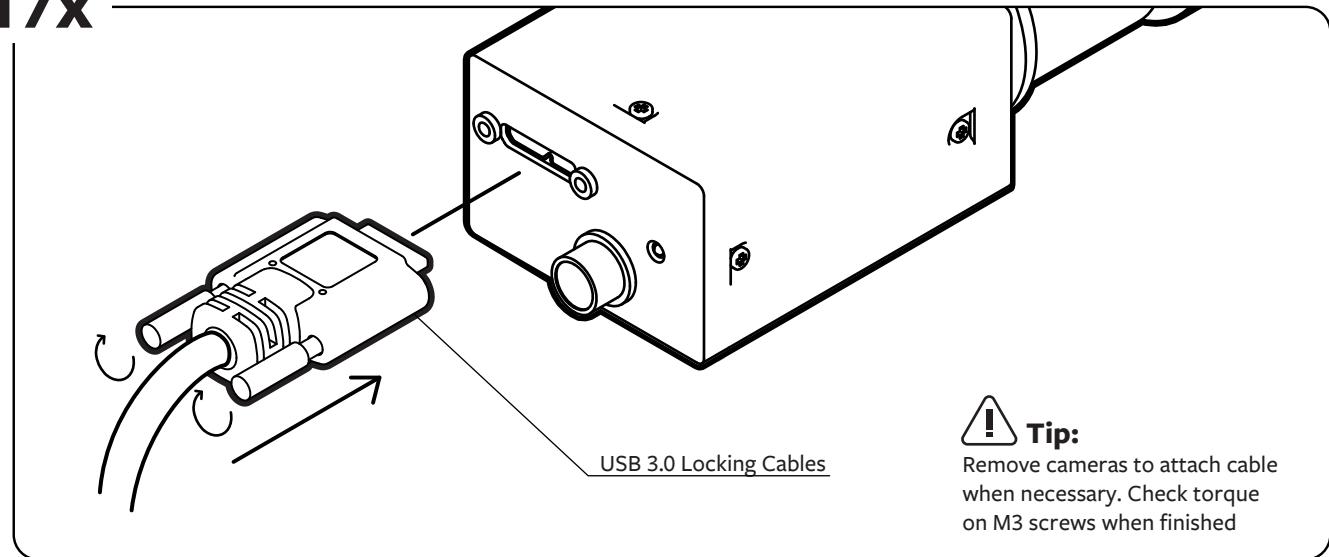
17x



# 3

## 13. USB 3.0 Cables

17x



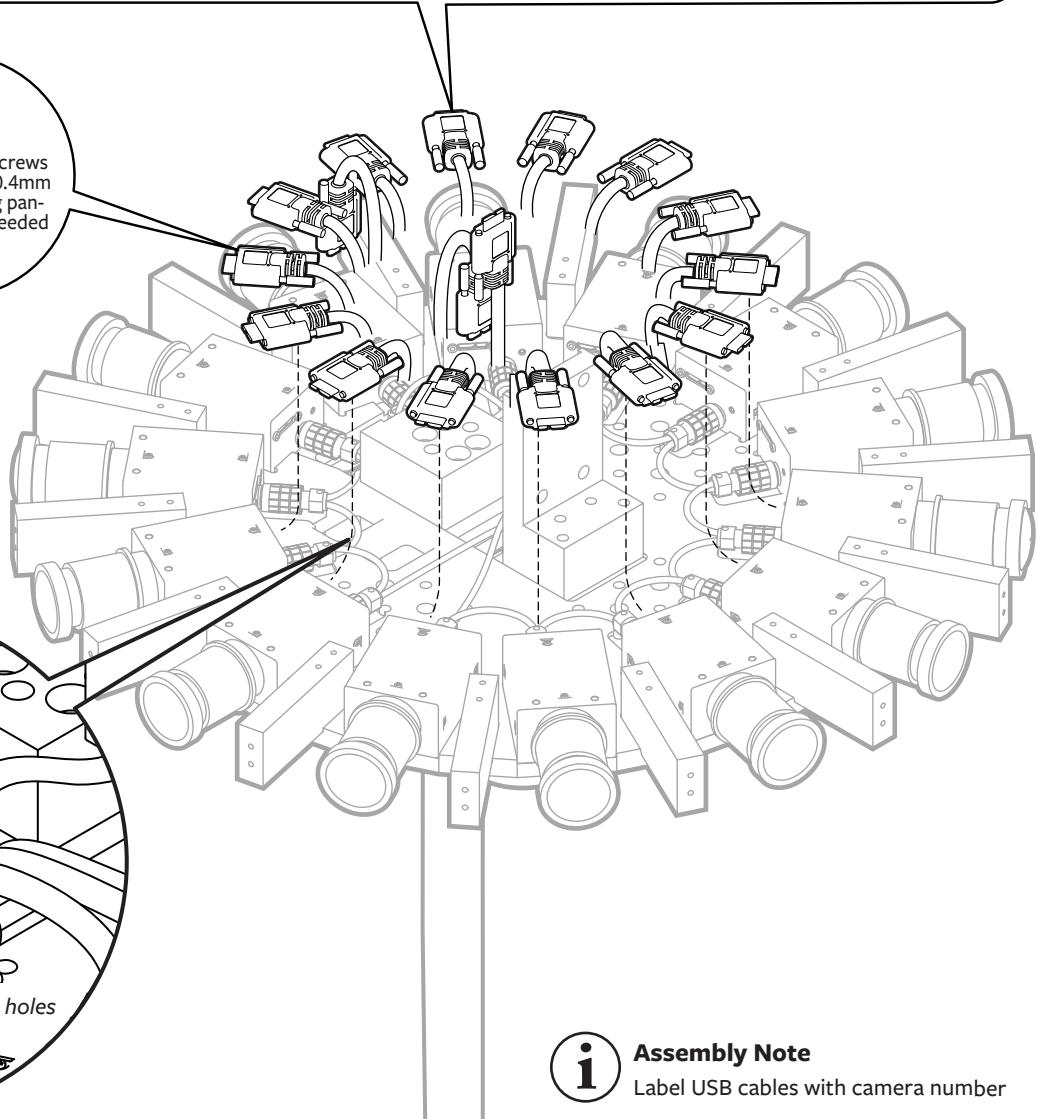
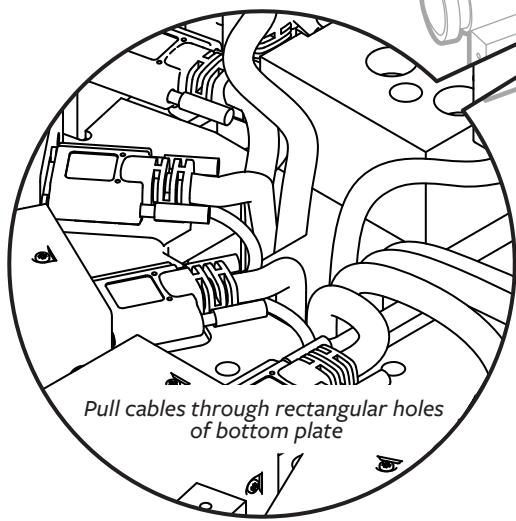
⚠ **Tip:**

Remove cameras to attach cable when necessary. Check torque on M3 screws when finished



**Tip:**

Replace locking screws with M2 thread, 0.4mm pitch, 20mm long pan-head screws as needed



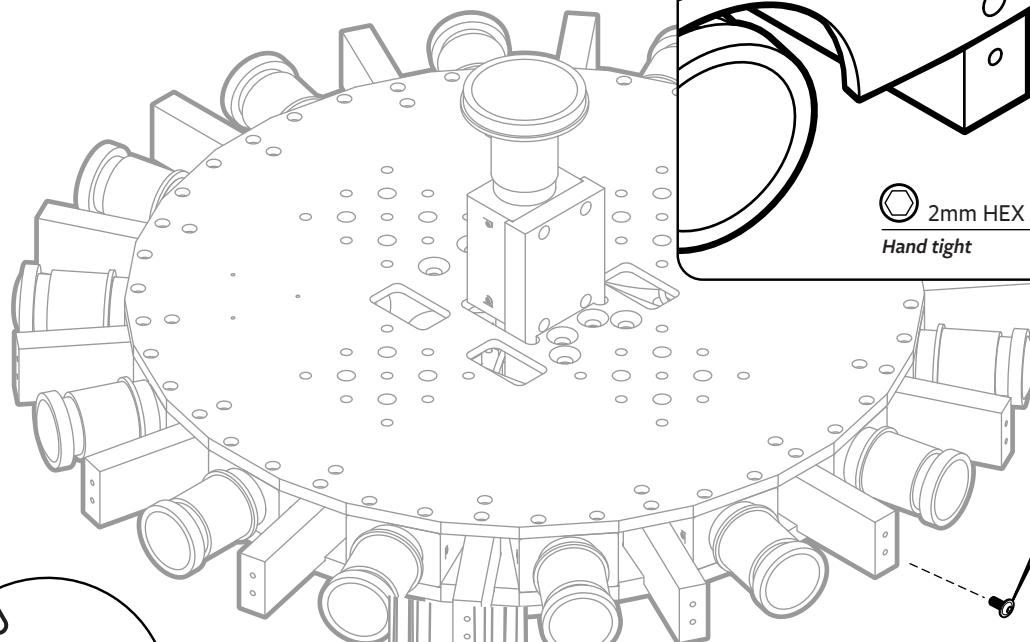
**Assembly Note**

Label USB cables with camera number

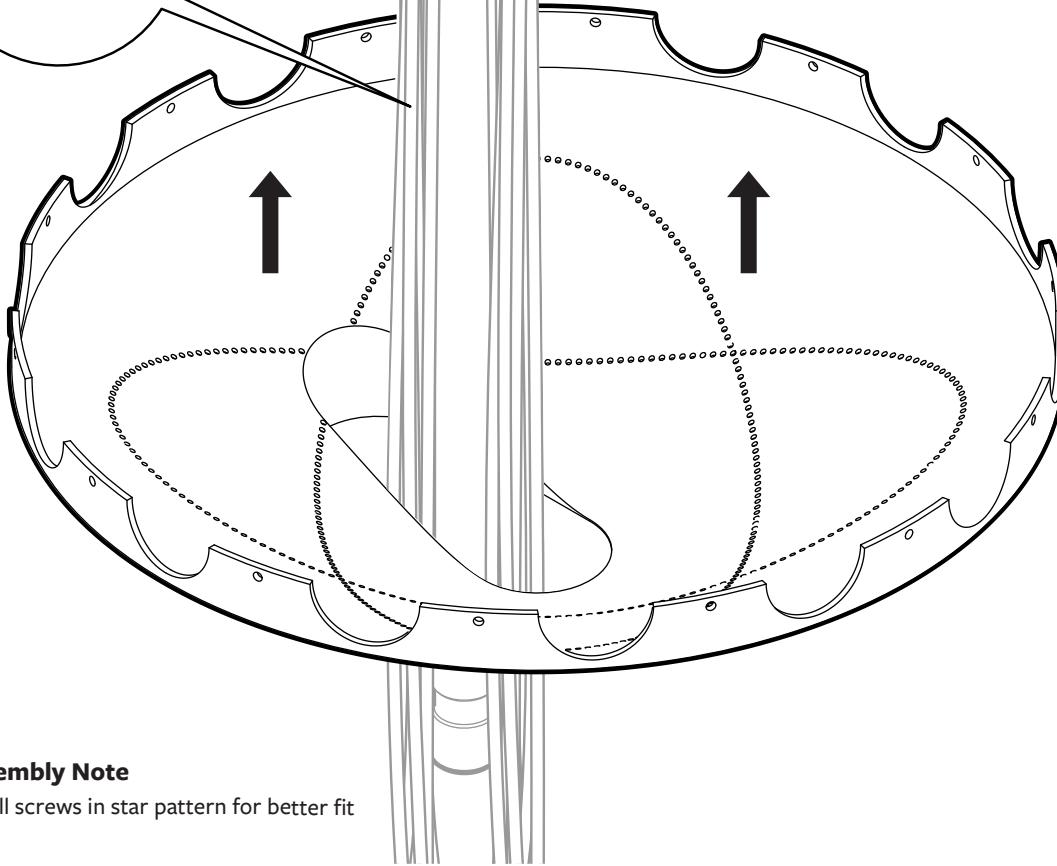
# 3

## 14.

### Bottom Shell

**Tip:**

All USB cables should fit through opening of bottom shell



## 14x

M3 Flanged  
Button-Head  
Socket Cap Screw

M3, 10mm

2mm HEX

Hand tight

2mm  
HEX

**Assembly Note**

Install screws in star pattern for better fit

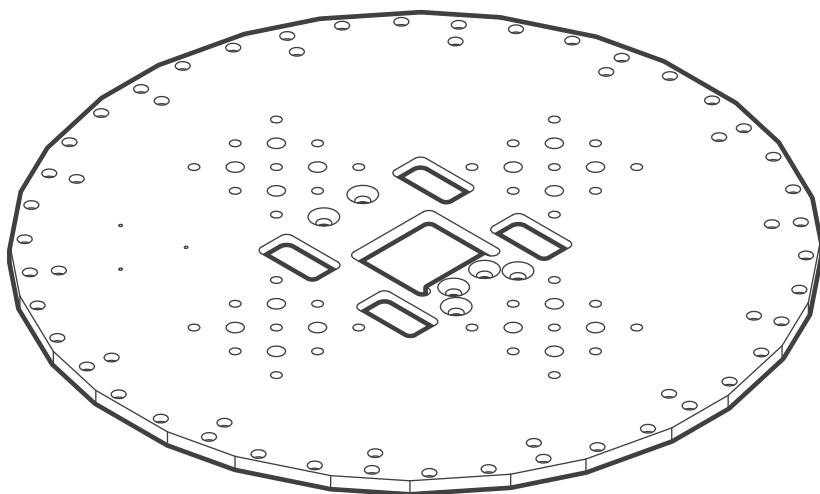
# 3

## 15. Top Plate



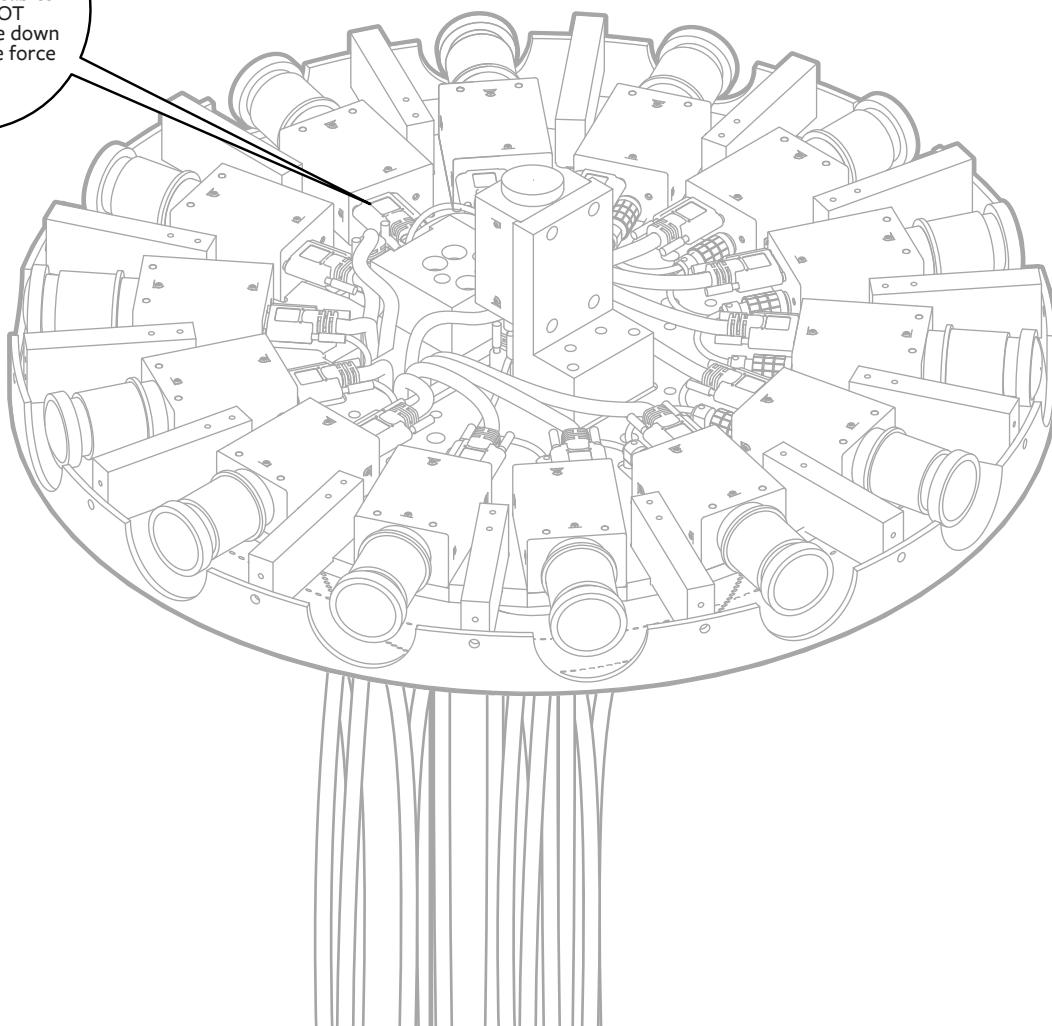
### Assembly Note

Optional: Connect cameras to computer to test first



#### Tip:

Make sure all cables fit well. DO NOT push top plate down with excessive force



# 3

## 16.

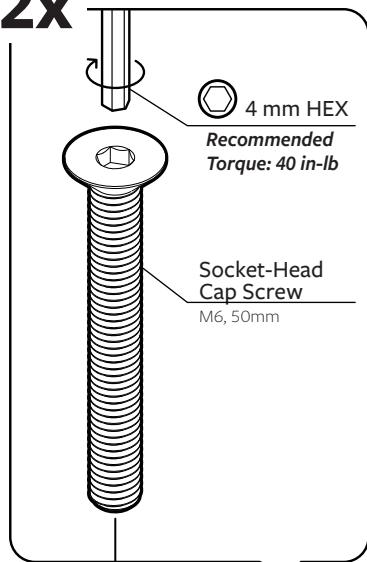
### Top Plate Hardware



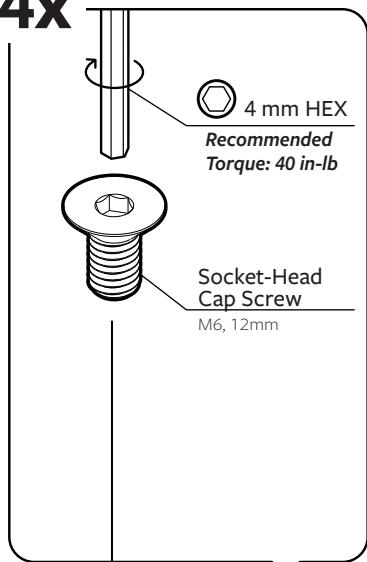
#### Assembly Note

Install M3 socket-head cap screws in star pattern for better fit

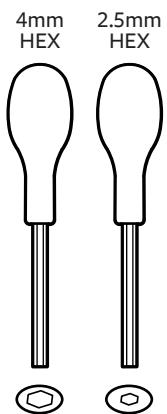
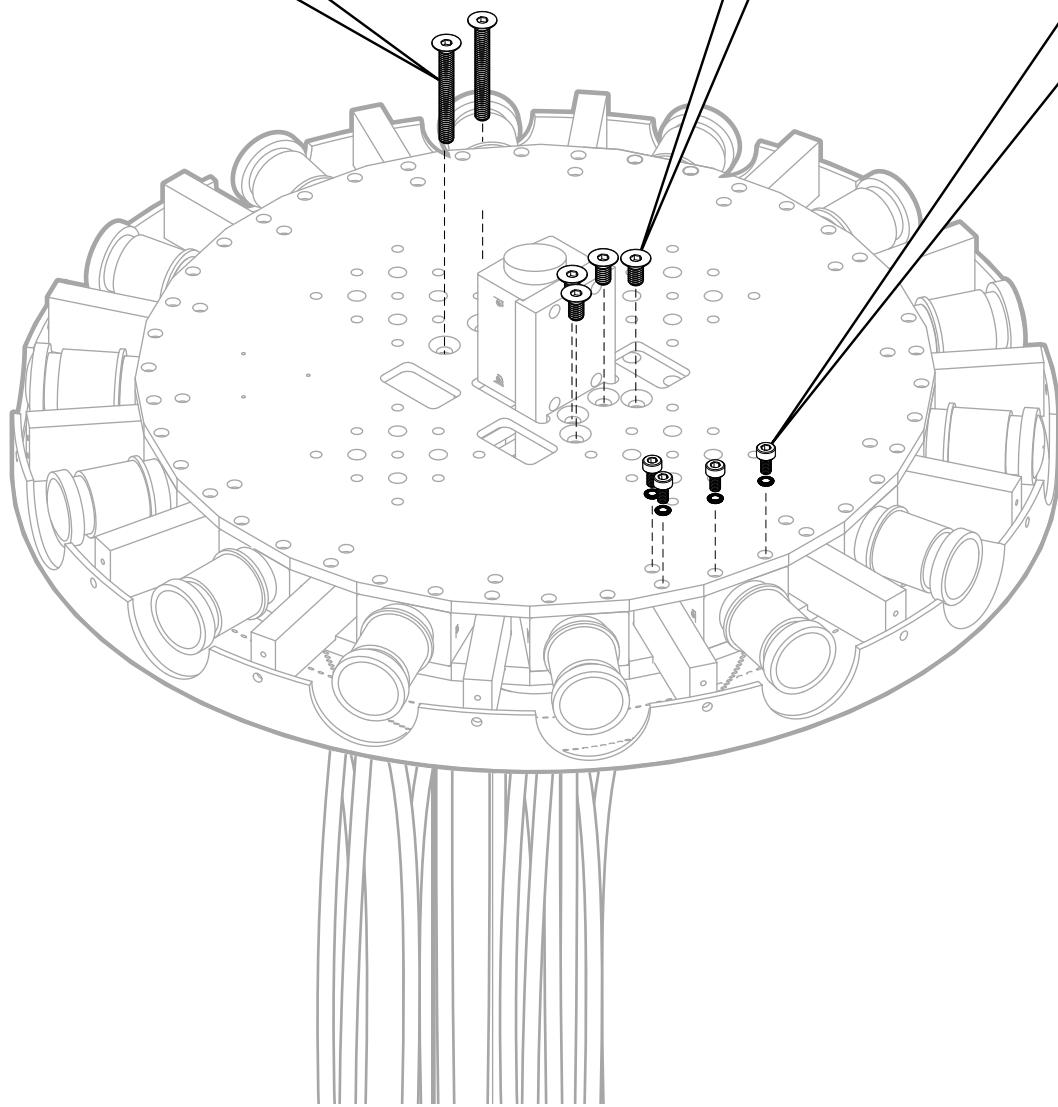
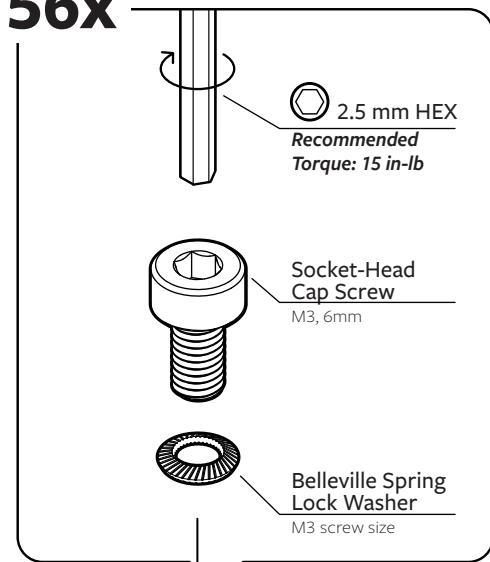
**2x**



**4x**



**56x**



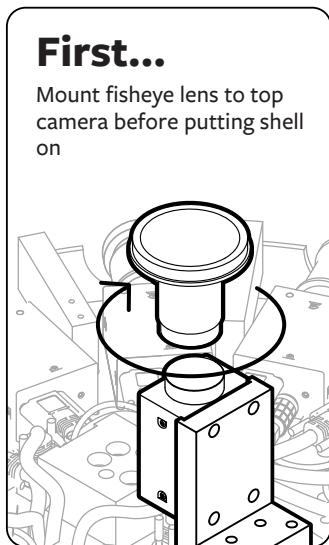
# 3

## 17. Top Shell



### Assembly Note

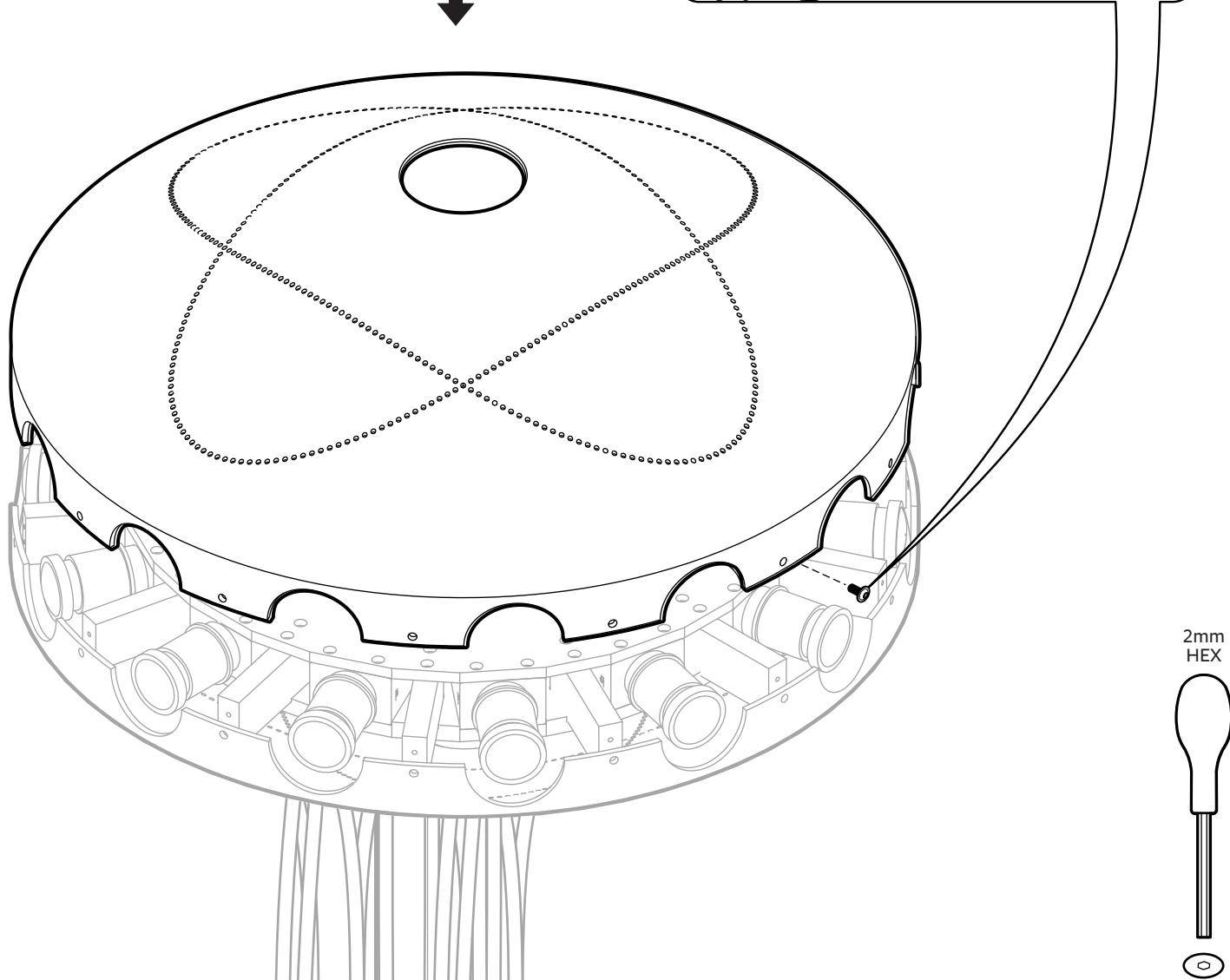
Install screws in star pattern for better fit



**14x**

M3 Flanged  
Button-Head  
Socket Cap Screw  
M3, 10mm

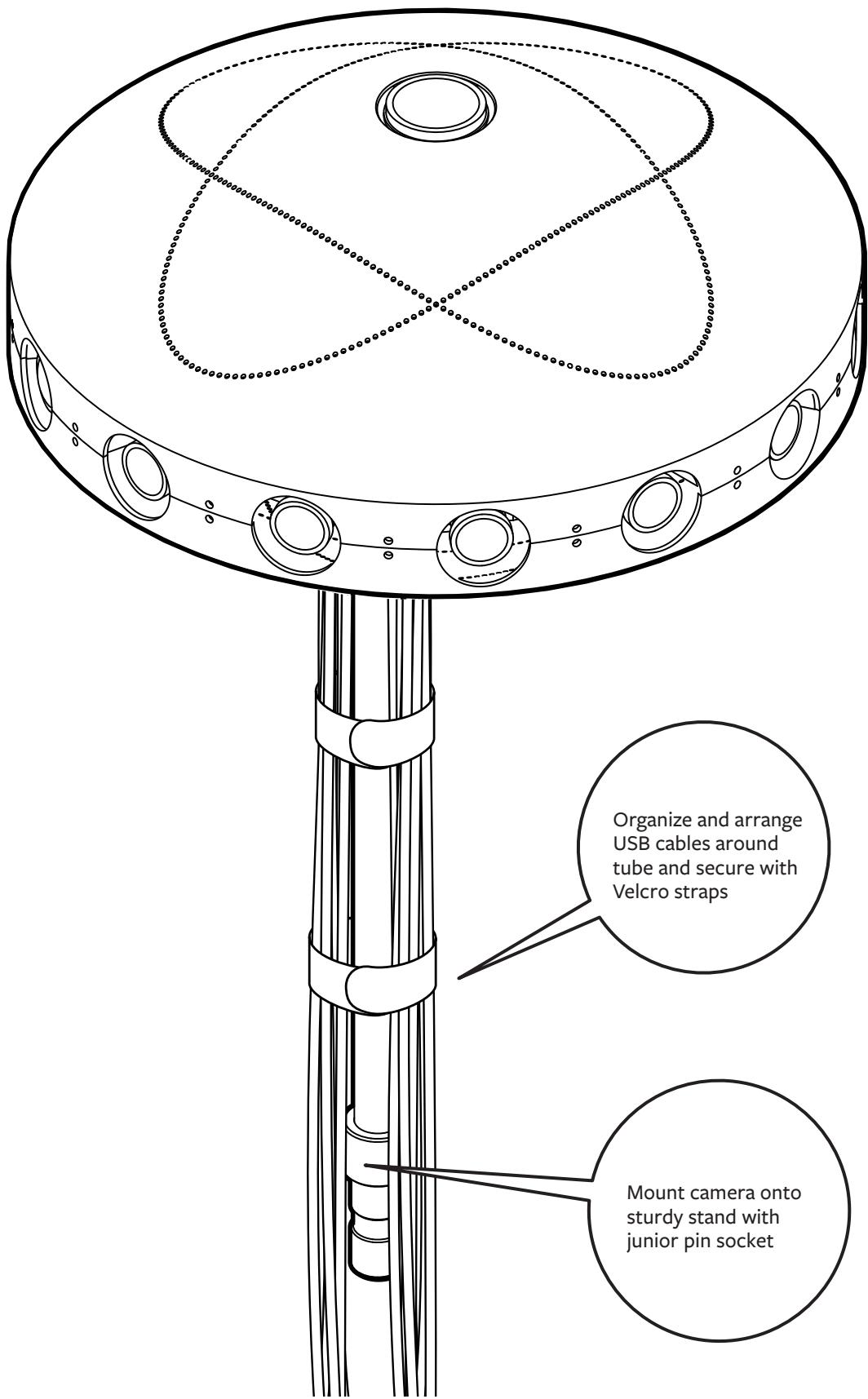
2mm HEX  
*Hand tight*



# 3

## 18.

### Cable Management & Stand



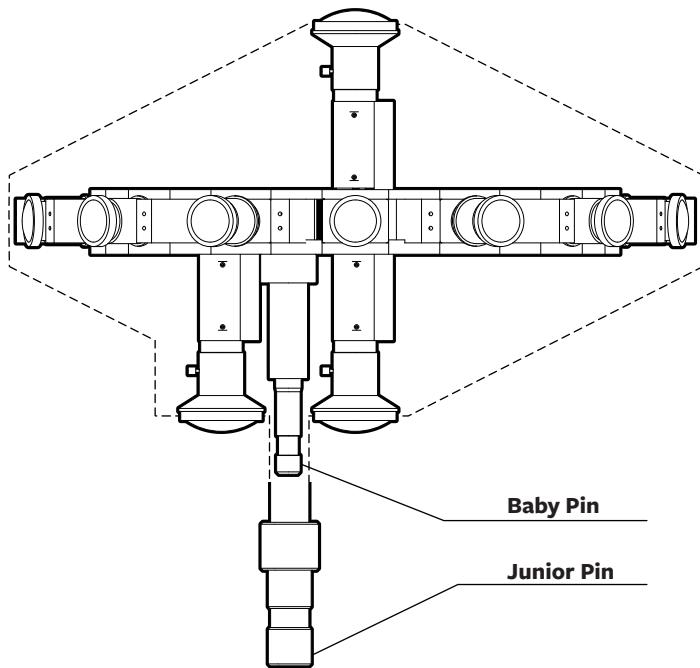
# 4

**Camera Info**

# 4

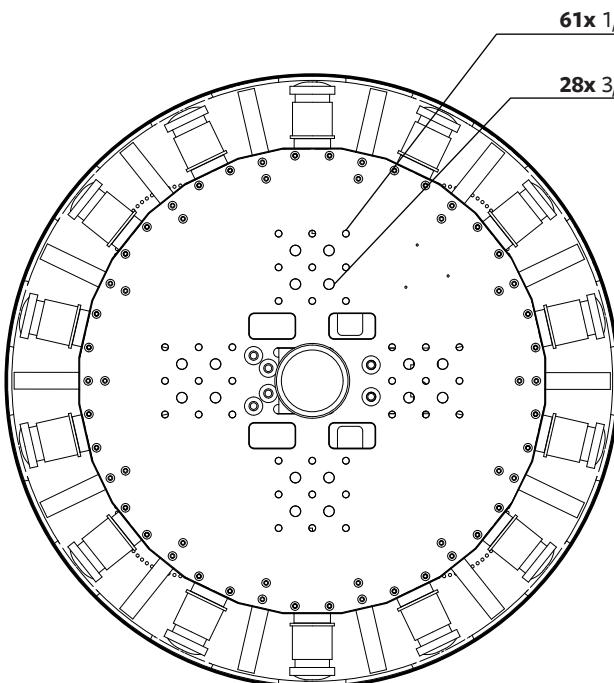
## 1a.

Mounting the Camera to Standard Grip Equipment

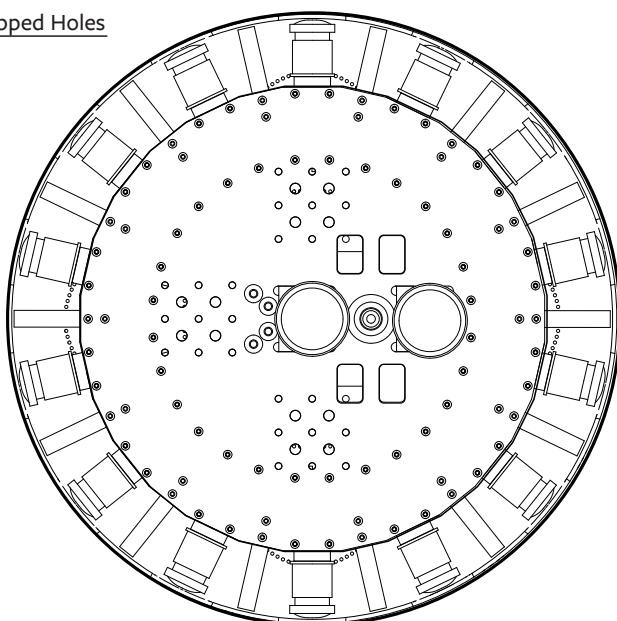


## 1b.

**Attachment Options** 89 MULTIPURPOSE MOUNTING HOLES



TOP PLATE

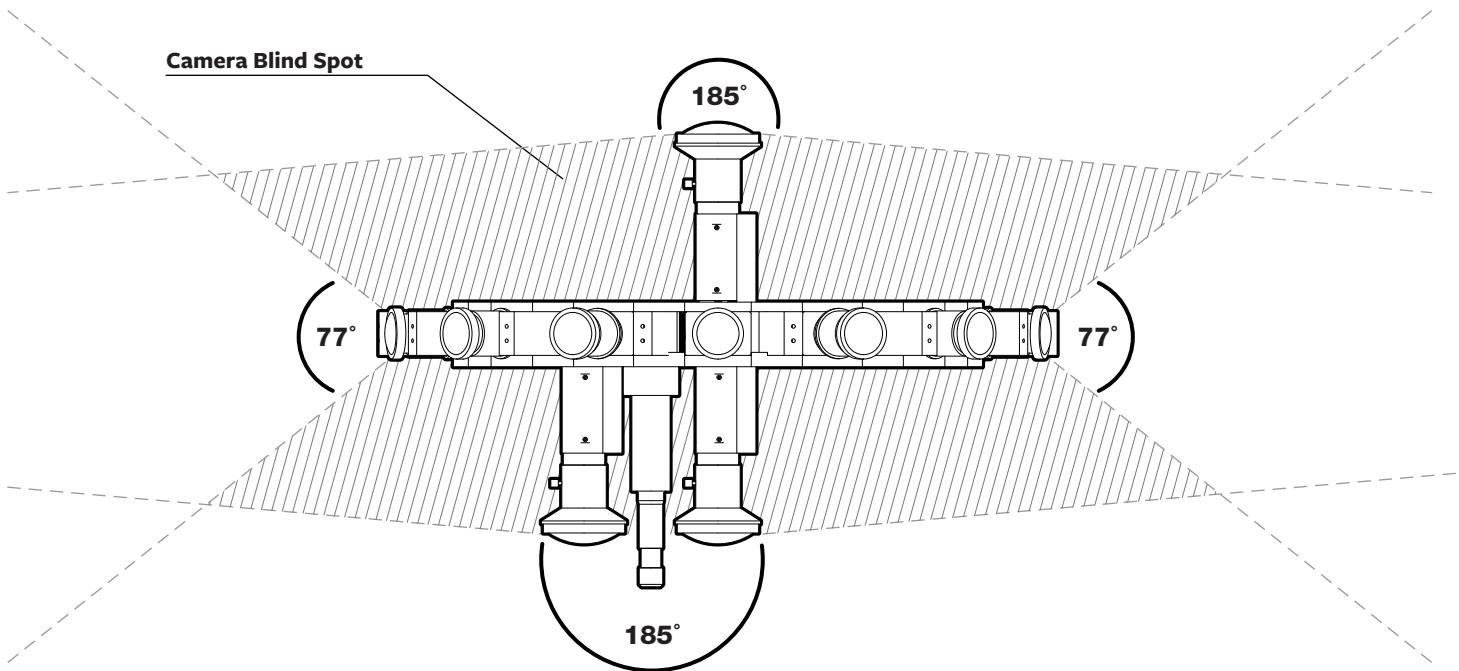


BOTTOM PLATE

# 4

## 2a.

### Blind Spot for Mounting Accessories



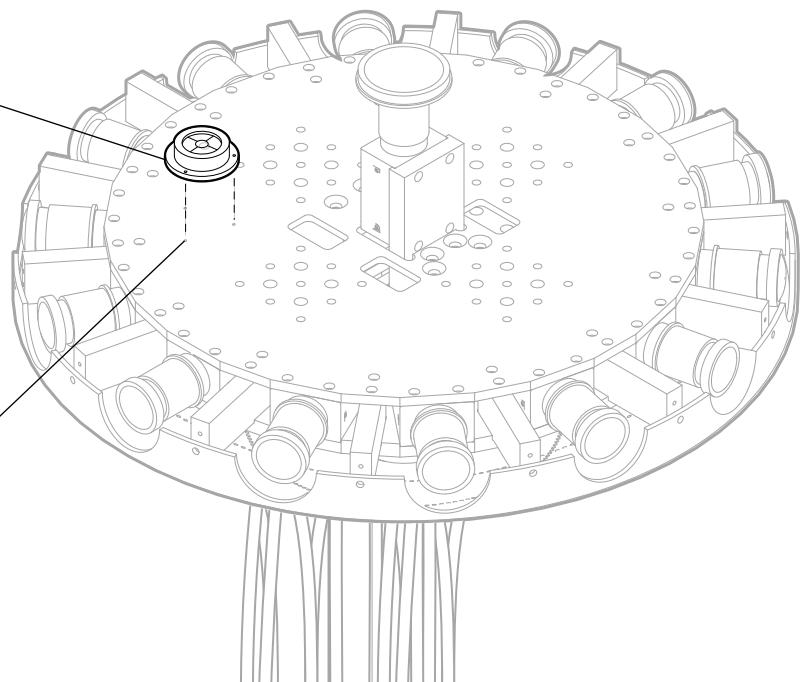
## 2b.

### Bull's-Eye Level (Optional)

#### Surface mount bull's-eye level

1-3/4" Base Diameter (McMaster-Carr #2198A87)

Tapped Holes - M2 Thread, 0.4 pitch



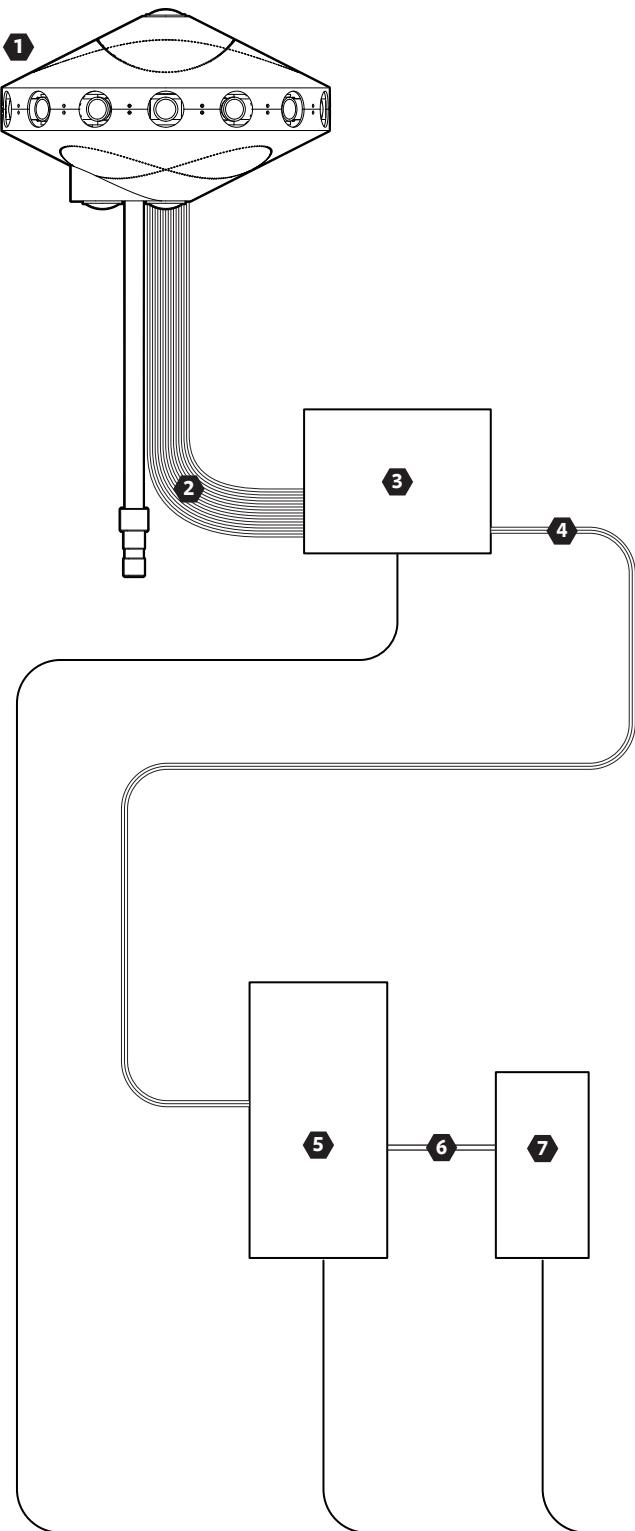
# 5

## **System Set Up Instructions**

# 5

## 1.

### Computer (Computer) System Overview



#### SURROUND 360 SYSTEM with Fiber Optic Extension

- ① Surround 360 Camera
- ② USB 3.0 High Speed Type A to Micro-B Cables x17
- ③ Fiber Optic Breakout Box
- ④ PCIe x8 Active Optical Cable
- ⑤ Computer (Computer)
- ⑥ SFF-8644 to SFF-8644 MiniSAS Cable x2
- ⑦ Raid Tower
- ⑧ Power Supply

#### ① SURROUND 360 Camera

- 17x Point Grey Grasshopper Cameras
- 14x Wide-Angle Lenses
- 3x Fisheye Lenses
- GPIO Trigger Cable

#### ③ FIBER OPTIC BREAKOUT BOX

- 1x Backplane With Power Supply
- 5x PCI Express x4, 4 Ports USB 3.0 Expansion Card
- 1x PCIe x16 Host Interface Card

#### ⑤ COMPUTER SPECIFICATIONS

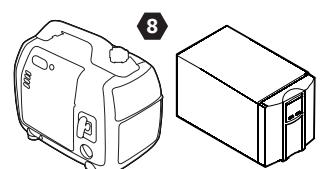
- Intel Core i7 Processor
- Motherboard With 4 x PCI Express x16 slots
- 64GB Ram
- 1GB PCI-E x16 Video Card
- 2.5" 128GB SSD
- Operating System - Ubuntu 14.04 LTS

#### ⑦ RAID TOWER SPECIFICATIONS

- 1 Gb/s x 17 Cameras = 17 Gb/s (@ 30fps)
- 8 x 1TB SSD RAID: 1 Hour of Continuous Raw Video Capture

#### ⑧ POWER SUPPLY

- 110V AC
- Alternative Options: UPS Backup Battery or Bujet Generator



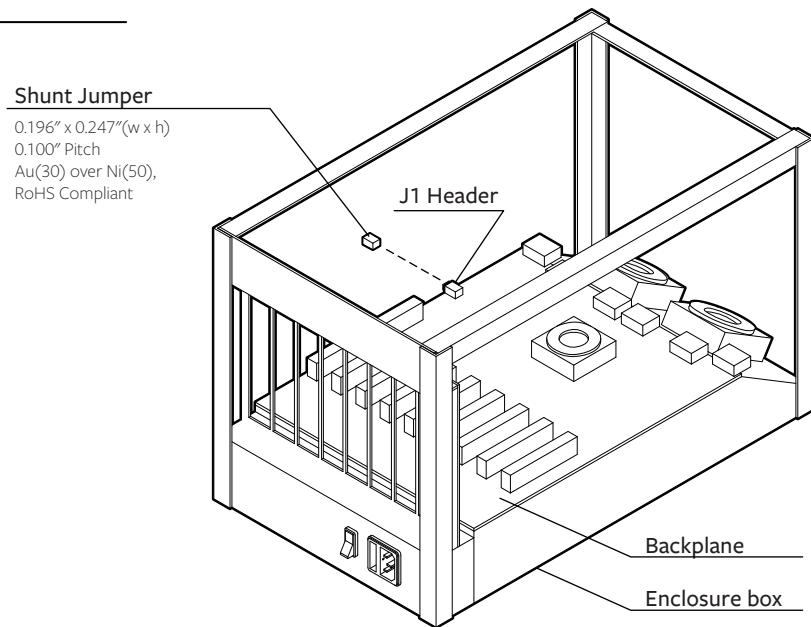
# 5

## 2a.

### Fiber Optic Breakout Box

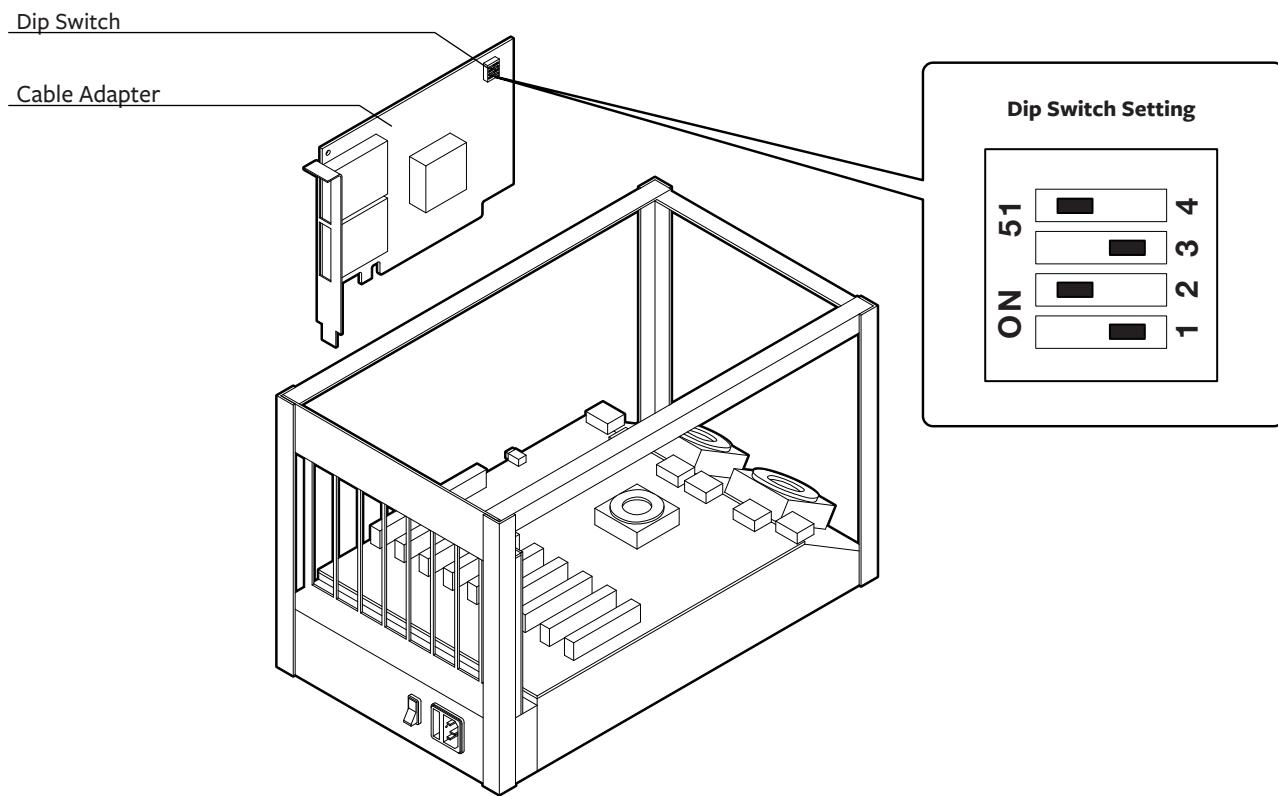
#### STEP 1

Insert jumper to a header on the backplane labeled J1



#### STEP 2

Insert PCIe x8 Gen 3 cable adapter and set dip switch setting



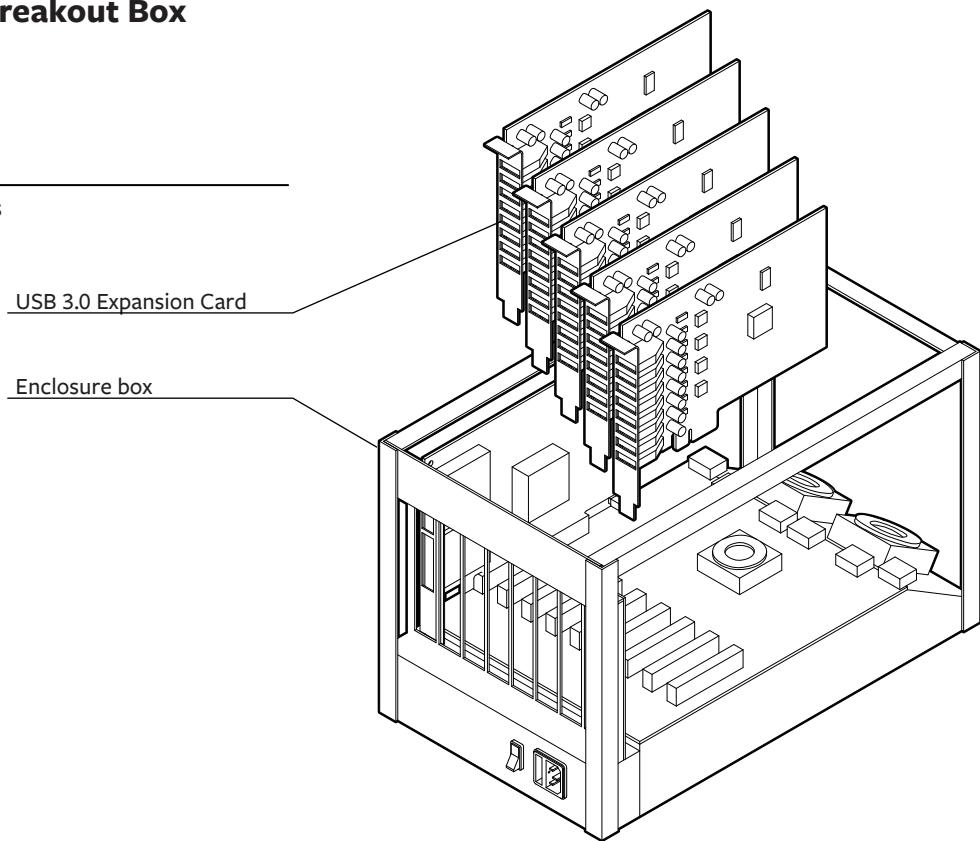
# 5

## 2b.

### Fiber Optic Breakout Box

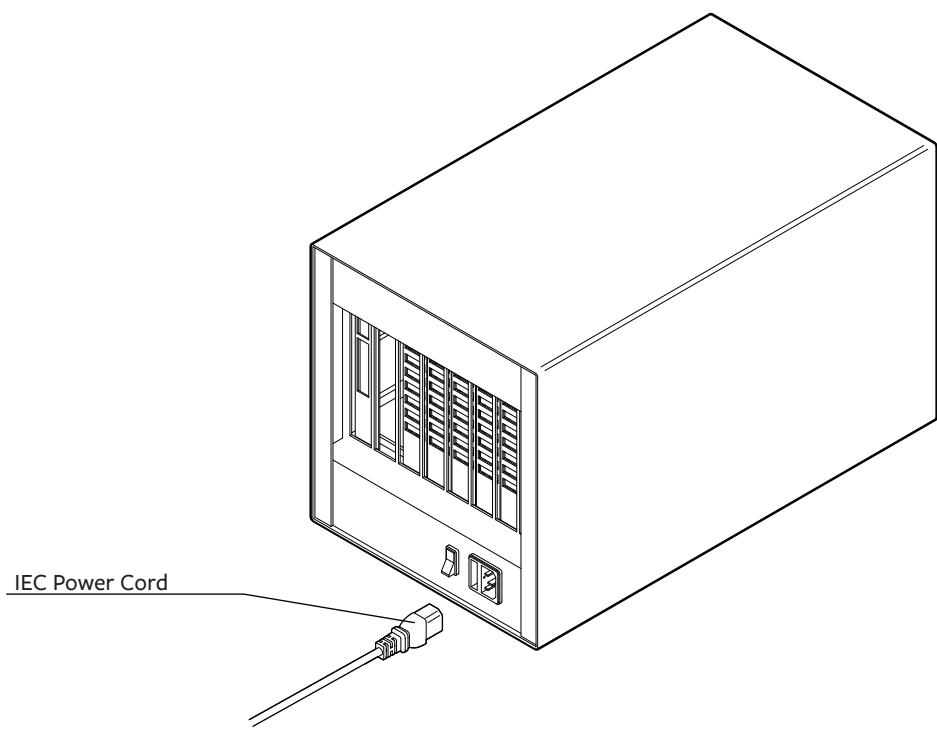
#### STEP 3

Insert 5 PCIe x4 USB 3.0 Expansion Cards



#### STEP 4

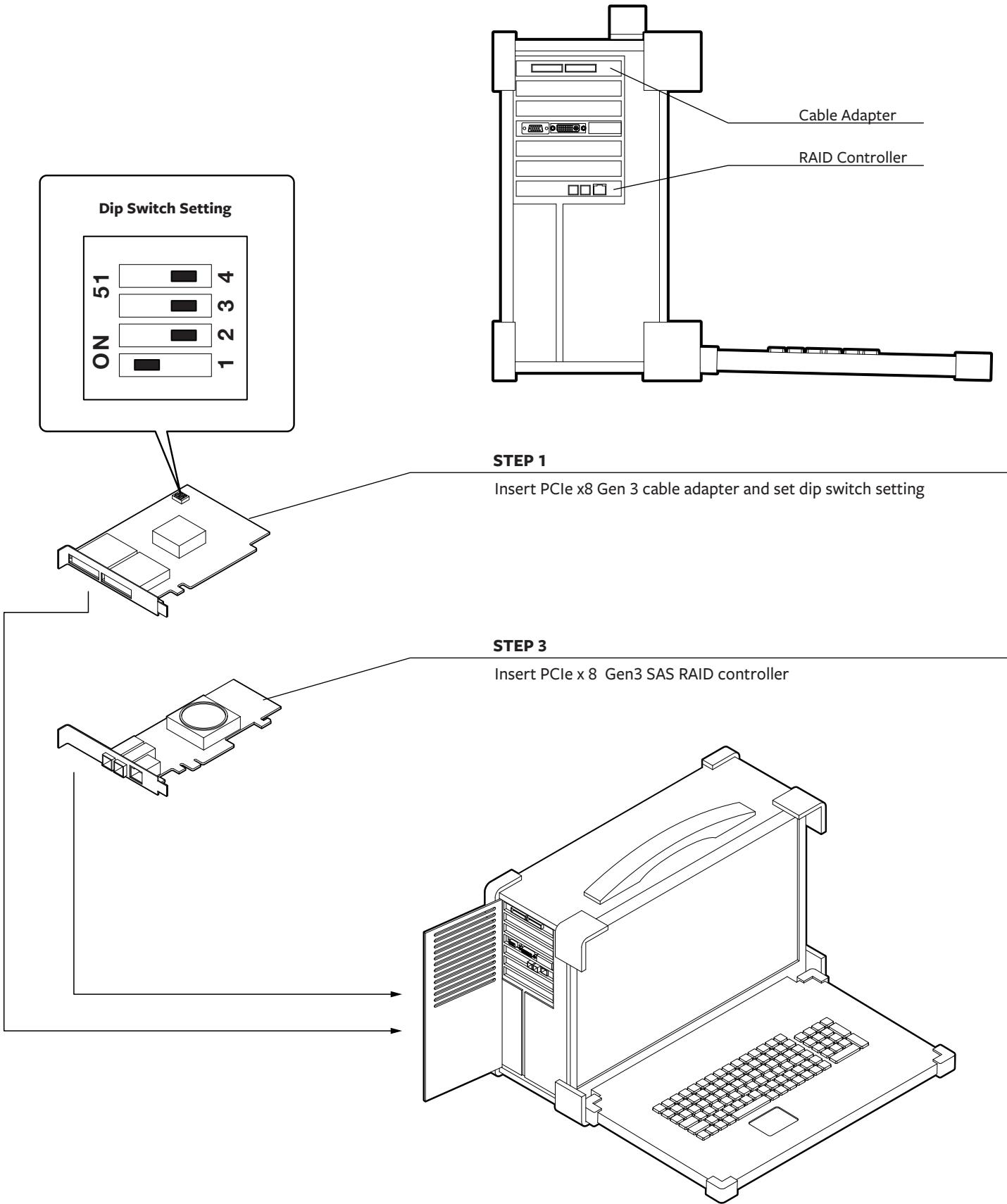
Close enclosure and connect power cable



# 5

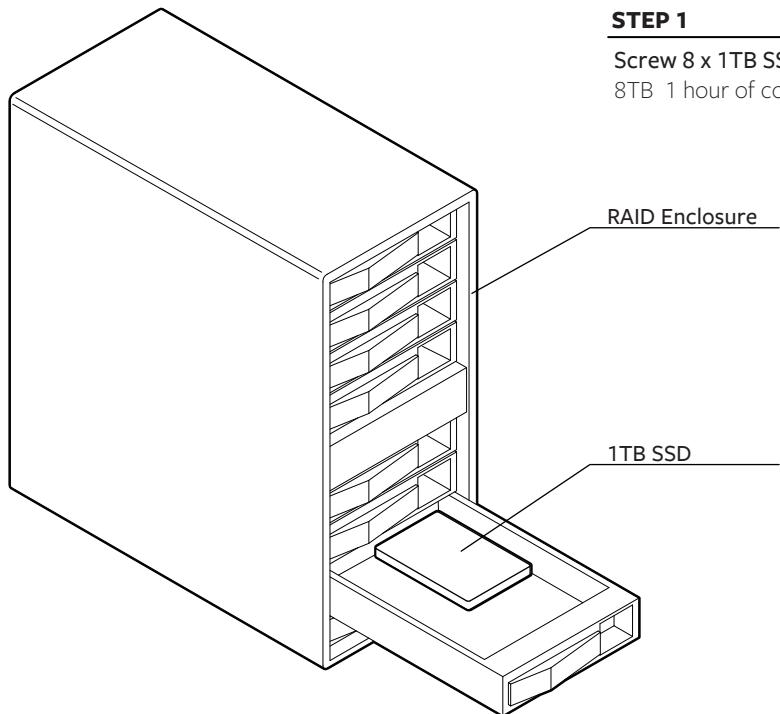
## 3.

### Computer - Lunchbox PC



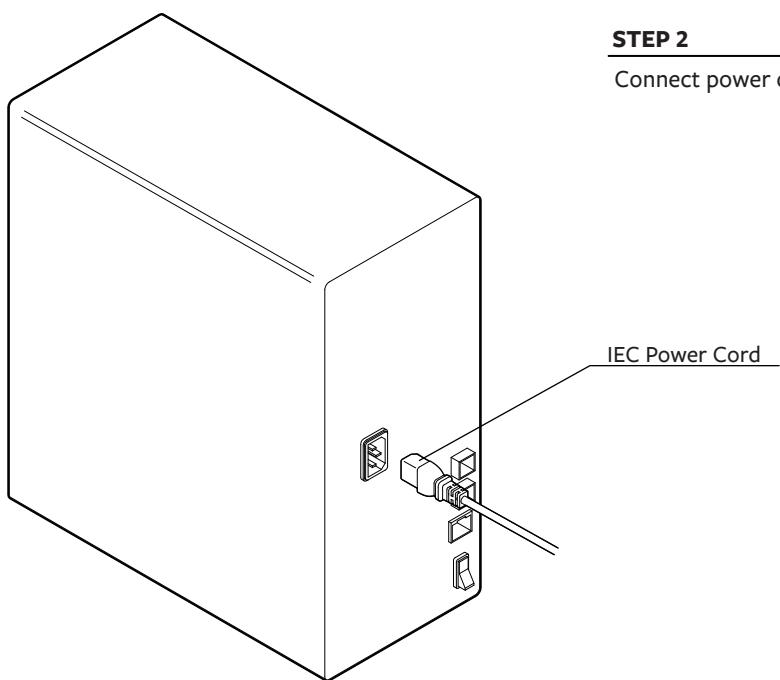
# 5

## 4. RAID Tower



### STEP 1

Screw 8 x 1TB SSDs into enclosure  
8TB 1 hour of continuous raw video capture



### STEP 2

Connect power cable

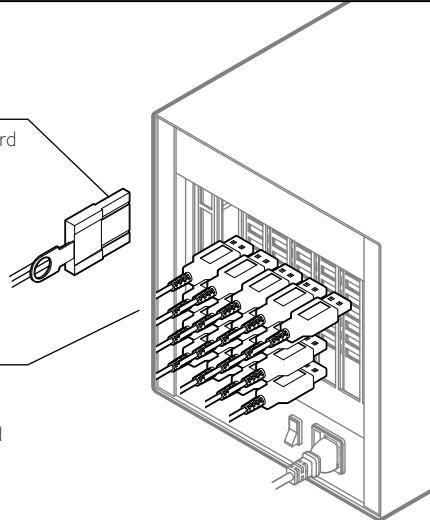
# 5

## 5. Cable Connections

### Fiber Optic Breakout Box

#### PCIe x8 Active Optical Cable

Connect TARGET end to adapter card top slot (furthest from backplane)

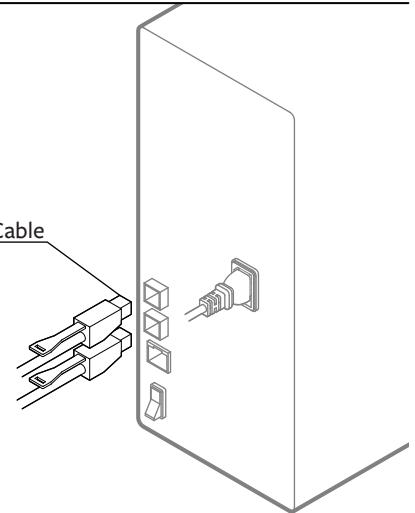


#### 17 x USB 3.0 Cables

Plug camera USB 3.0 cables:  
4 per adapter, every other slot,  
extra one any slot on remaining card

### RAID Enclosure

#### External 4x HD Mini-SAS Cable



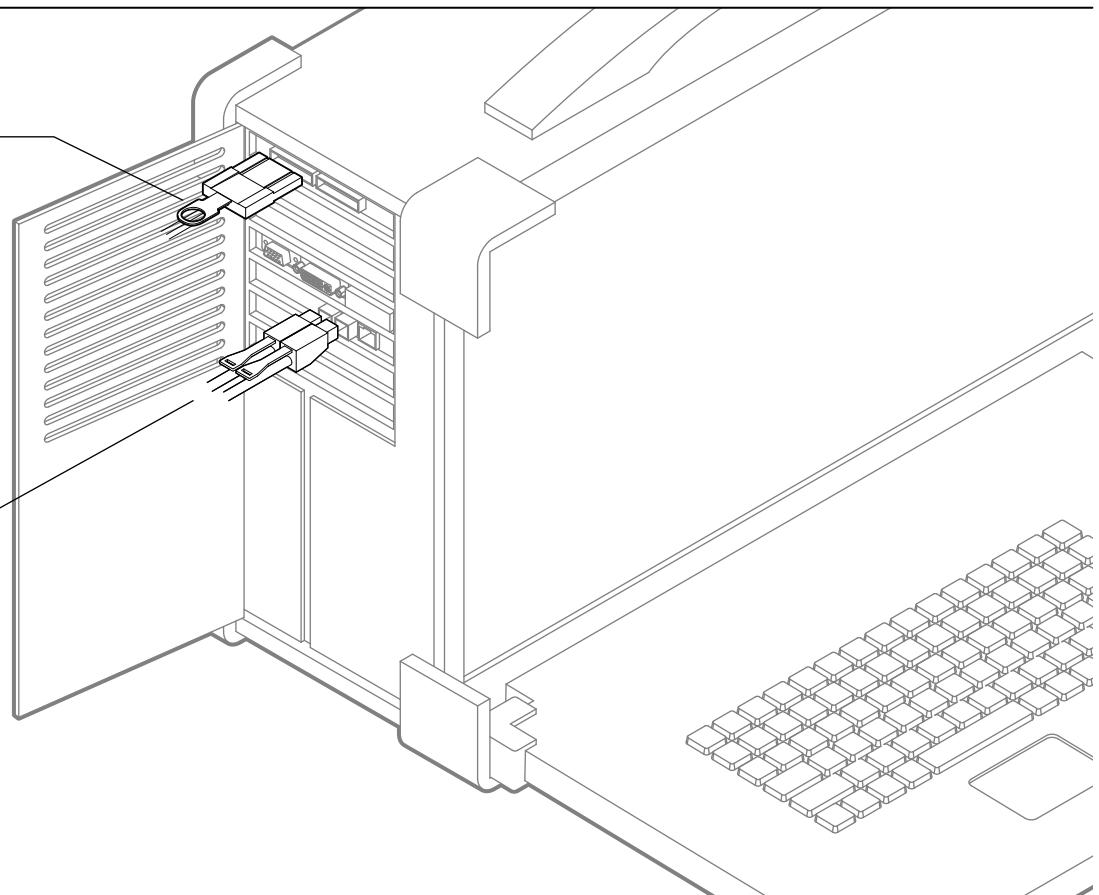
### Computer

#### PCIe x8 Active Optical Cable

Connect HOST end to adapter card left slot (furthest from motherboard)

#### External 4x HD Mini-SAS Cable

#### ICE Power Cable

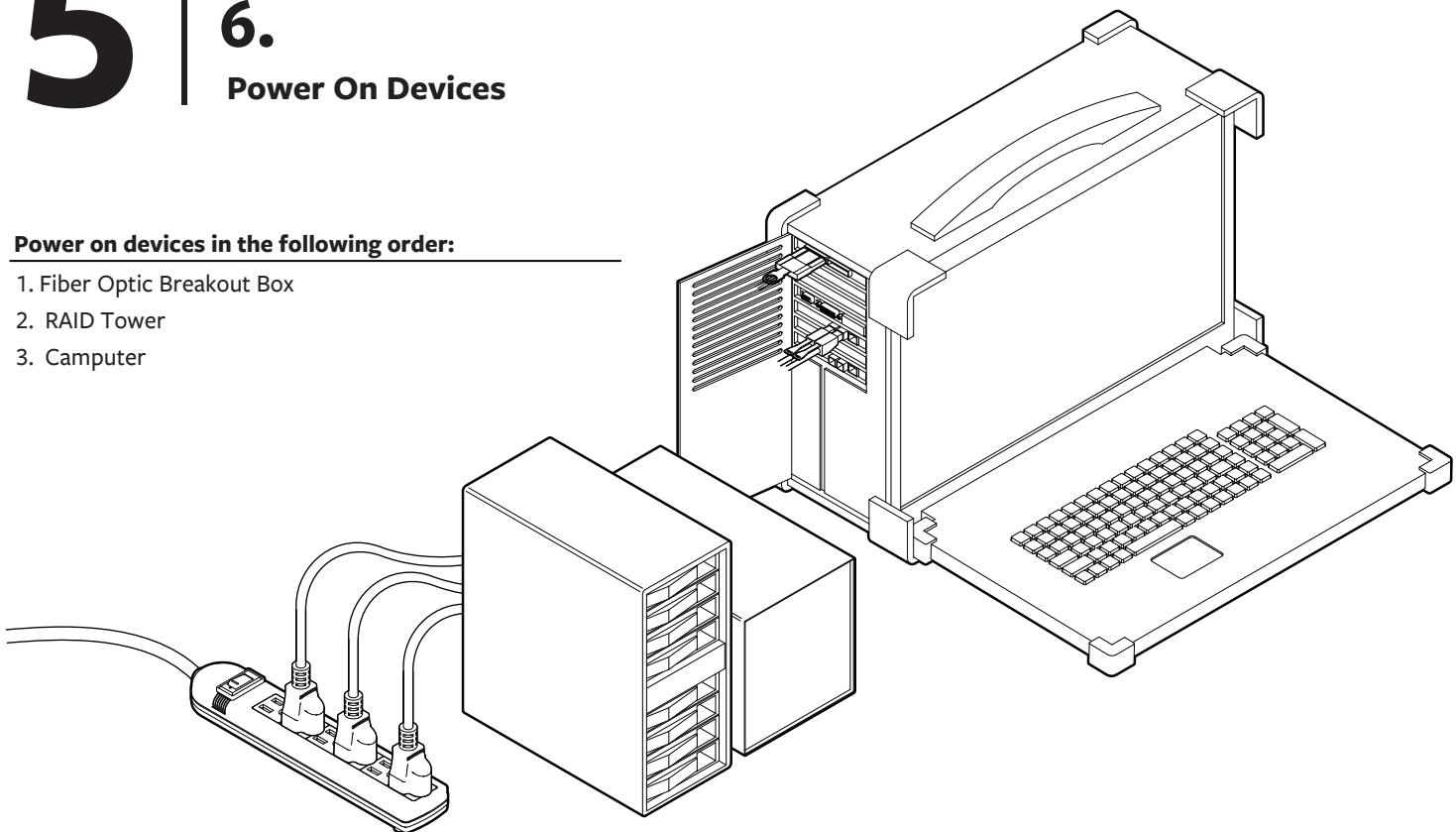


# 5

## 6. Power On Devices

**Power on devices in the following order:**

1. Fiber Optic Breakout Box
2. RAID Tower
3. Computer



# 7.

## Set Up Surround 360 Camera Control Software

Follow README file to setup Computer:  
<https://github.com/facebook/surround360>



# 6

## Capturing & Rendering Instructions

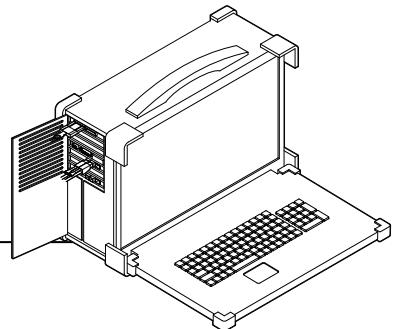
# 6

## 1a.

### How to Capture with Web GUI

#### Step 1. Start Program

To access the web GUI, open a browser (Chrome preferred; no Safari) and navigate to <http://localhost>



The web capture GUI provides all of the controls necessary to operate the Surround 360 and preview live images from any 4 of its 17 camera

The screenshot shows the Surround 360 Web GUI interface at <http://localhost>. The interface includes the following components:

- Record Video** section:
  - Actions :**
    - Start and stop camera control software
    - Update live preview
  - Label**: 1468888778
  - Duration of Capture**:
    - Shutter: 0 min 30 sec (ms)
    - Gain: 20.000 ms
  - Select Preview Cameras :** Up to 4 cameras (List: Camera 0, Camera 1, Camera 2, Camera 3, Camera 4, Camera 5, Camera 6, Camera 7, Camera 8)
- Preview Panels**:
  - PREVIEW IMAGE FROM CAMERA 1
  - PREVIEW IMAGE FROM CAMERA 2
  - PREVIEW IMAGE FROM CAMERA 3
  - PREVIEW IMAGE FROM CAMERA 4
- Latest Video Stats**
- Latest Previews**

Annotations provide additional information:

- Actions :**
  - Start and stop camera control software
  - Update live preview
- Label**
  - Folder & file prefix (must be unique)
- Duration of Capture**
  - Shutter Speed**
    - in milliseconds
    - DO NOT go longer than 20 ms (1/50 second)
    - for a 180° shutter angle at 30 fps, target 16.7 ms
  - Gain - in dB**
    - in general, use 0dB
    - try hard not to go above 3dB
- Select Preview Cameras :** Up to 4 cameras
- Preview Panels**

# 6

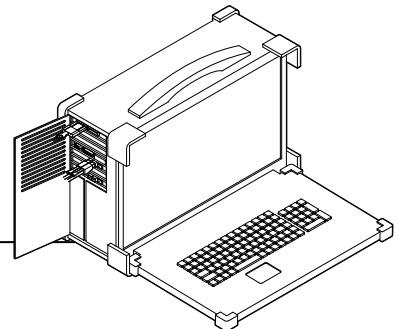
## 1b.

### Using the Web Capture GUI

#### Step 2. Start Recording

GUI control changes once you hit the start program button.

You will be able to stop the capture and update the live preview while the camera is capturing.



http://localhost

### Record Video

Start Program Stop Program Start Recording Stop Recording Update Preview

Label: 1468888778

0 min 30 sec 20.000 ms

Shutter Gain

Preview

Camera 0
Camera 1
Camera 2
Camera 3
Camera 4
Camera 5

**Actions :**  
- Start and stop recording

#### Step 3. Recording in Progress

GUI control changes once you hit the start program button.

You will be able to stop the capture and update the live preview while the camera is capturing.

http://localhost

### Record Video

Start Program Stop Program Start Recording Stop Recording Update Preview

Elapsed time: 00 m 20 s, FPS: 29.9, Dropped frames so far: 0

Progress Info  
- Elapsed time, frames per second and drop frames

Shutter Gain

Preview

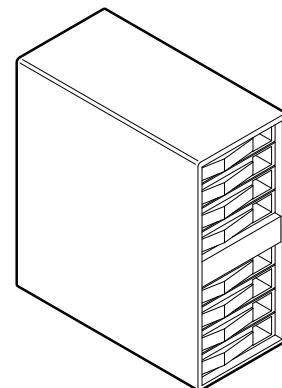
Camera 0
Camera 1
Camera 2
Camera 3
Camera 4
Camera 5

**Tips**  
It is safe to stop capture midway

# 6

## 2.

### How to Mount & Verify Raid Tower



#### Step 1. Boot Ubuntu

#### Step 2. Open terminal

#### Step 3. Change to superuser

```
| sudo su  
password:
```

- enter password

#### Step 4. Verify RAID is online (8TB)

```
| fdisk -l
```

- Look for “/dev/sda : 8192 GB” (if not /dev/sda, note what the disk name is)

#### Step 5. Setup RAID

```
| /surround360/surround360_camera_ctl/scripts/setup.sh
```

- Check for path

#### Step 6. Set endpoint for preview

```
| /ffserver
```

- Hit enter twice after running

#### Step 7. Verify storage pairing

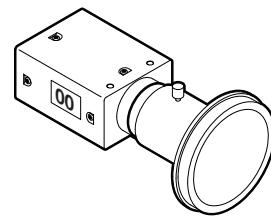
```
| /surround360/surround360_camera_ctl/scripts/df -h
```

- Make sure /dev/sda is paired with media/raidname

# 6

## 3.

### How to Verify Camera Connections



Open FlyCapture (Point Grey capturing software)

| flycap

- Confirm all connections are USB 3.0 and total of 17 cameras detected

(x) (−) FlyCapture 2 Camera Selection 2.9.3.43

Camera List (17 cameras detected)				Camera Information	
Serial #	Model	Interface	IP Address	Serial Number:	16130496
15355848	Grasshopper3 GS3-U3-41C6C	USB 3.0	N/A	Model:	Grasshopper3 GS3-U3-41C6C
15636785	Grasshopper3 GS3-U3-41C6C	USB 3.0	N/A	Vendor:	Point Grey Research
15636826	Grasshopper3 GS3-U3-41C6C	USB 3.0	N/A	Sensor:	CMOSIS CMV4000 (1" Color CMOS)
15636828	Grasshopper3 GS3-U3-41C6C	USB 3.0	N/A	Resolution:	2048x2048
15636829	Grasshopper3 GS3-U3-41C6C	USB 3.0	N/A	Interface:	USB 3.0
15636830	Grasshopper3 GS3-U3-41C6C	USB 3.0	N/A	Bus Speed:	S5000
15636831	Grasshopper3 GS3-U3-41C6C	USB 3.0	N/A	IIDC Version:	1.32
15636832	Grasshopper3 GS3-U3-41C6C	USB 3.0	N/A	Firmware Version:	2.14.3.0
15636834	Grasshopper3 GS3-U3-41C6C	USB 3.0	N/A	Firmware Build Time:	Tue Apr 21 18:51:25 2015
				Driver	None

Auto Force IP Refresh OK Configure Selected Cancel

#### Optional : Check focus by clicking on individual camera

All cameras are pre-focused, but critical focus should be checked before capturing. To check the focus of each lens, open a live preview by double clicking on the camera. Manually adjust the focus of the camera.

 Make sure ALL 17 cameras are recognized as USB 3.0



#### Tips

If a camera is not connected, or a camera says it is connected using USB 2.0, unplug cables from the breakout box and re-seat them in different buses until all 17 cameras are connected as USB 3.0. Remember that each camera must be alone in a USB 3.0 port pair in order to satisfy the requirement that there is only 1 camera per bus.

If this doesn't resolve the problem, try the following steps:

1. quit flycap
2. reset physical USB connections
3. run the following USB reset command:

| /home/facebook1/vr\_camera\_hw/scripts/usbreset.sh

# 6

## 4.

### How to use Flycapture to Preveiw (Optional)

#### Step 1. Start FlyCapture

| flycap

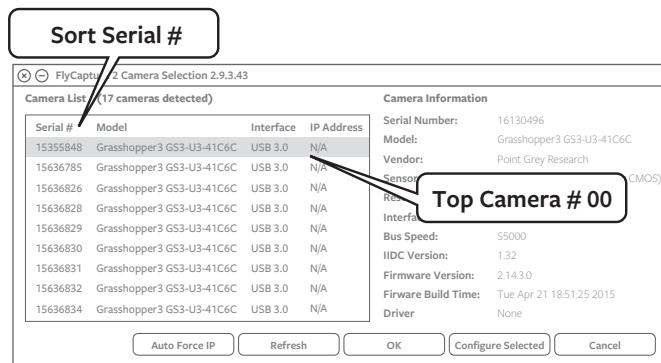
#### Step 2. Select a camera to preview

Camera are arranged in ascending sequential order starting with top camera (# 00).

#### Step 2. Go to setting panel from preview panel

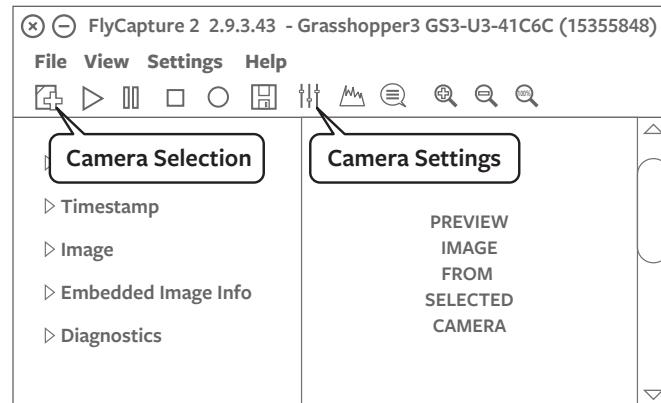
Set the following values:

- shutter speed in milliseconds
- gain (usually 0)
- framerate (usually 30)



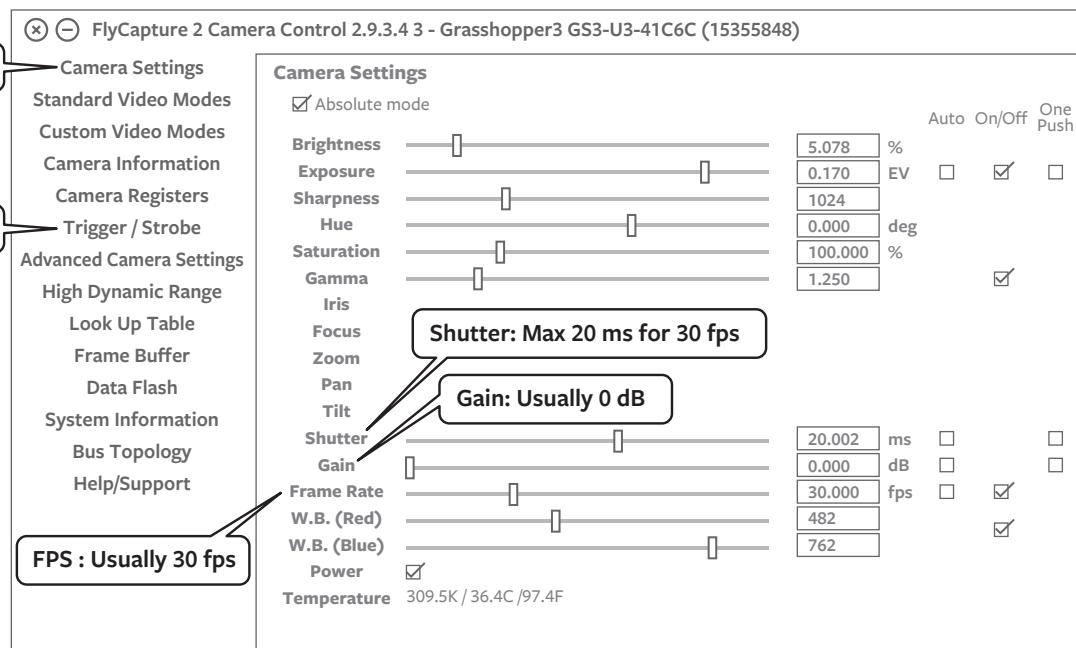
#### Step 3. Back to preview panel to check focus

All cameras are pre-focused, but critical focus should be checked before capturing. To check the focus of each lens, open a live preview by double clicking on the camera. Manually adjust the focus of the camera.



#### Step 4. Changing camera settings after you capture

Each time you capture using the Surround 360, all camera settings are set to capture settings, and preview is disabled. When you load flycap (e.g., to change settings), you'll see the Point Grey logo instead of a preview. To re-enable preview, find the "Trigger/Strobe" settings and uncheck "Trigger Control."



# 6

## 5.

### How to Use Command Line to Capture (Optional)

```
# check number of cameras
sudo CameraControl -list

# capture
sudo CameraControl -shutter [ms] -gain [dB] -nframes [frames] -dir [unique
label] \-numcams 17 -raw -debug -nbits 8

# cd /usr/local/bin
```

#### Arguments:

- shutter (in ms)
- gain (in dB)
- dir (use unique label, for directory creation)
  - convention: yyymmddhhmm\_shutterspeed
  - if you don't use a unique directory, it will overwrite
- nframes
  - 1800 frames per minute at 30 fps
- numcams
  - should be 17
- raw
- debug
- nbits
  - should be 8



#### Tips

If you need to interrupt the capture, use Control-C after you start to see heartbeats

#### Note:

CameraControl actually changes camera settings for all cameras (i.e., it overwrites the settings you see in flycap)

# 6

## 6.

### Checking Captured Media

#### After capturing is finished

Captured media can be found in /media/snoraid. To see files:

```
| ls -ltrh /media/snoraid
```

You'll see 2 bin files per capture + a cameranames.txt reference file.

```
-rw-r--r-- 1 root root 153 Jul 26 00:18 1468653916_test_cameranames.txt  
-rw-r--r-- 1 root root 29G Jul 26 00:18 1468653916_test_1.bin  
-rw-r--r-- 1 root root 32G Jul 26 00:18 1468653916_test_0.bin
```

Each frame is 20 MB per eye (40MB per stereo frame), and bin files can grow to enormous sizes, with a max size of (max RAID capacity / 2).

## 7.

### Shutting Down System

#### After capturing is finished or moving to a new shooting location

Shutdown the computer by using the menu, or by running:

```
| shutdown -h now
```

#### Then, physically power down devices in the following order:

1. Computer
2. RAID Tower
3. Fiber optic breakout box



#### Tips

Never disconnect the RAID before unmounting it. The safest way to unmount the RAID is to shut the computer down.

# 6

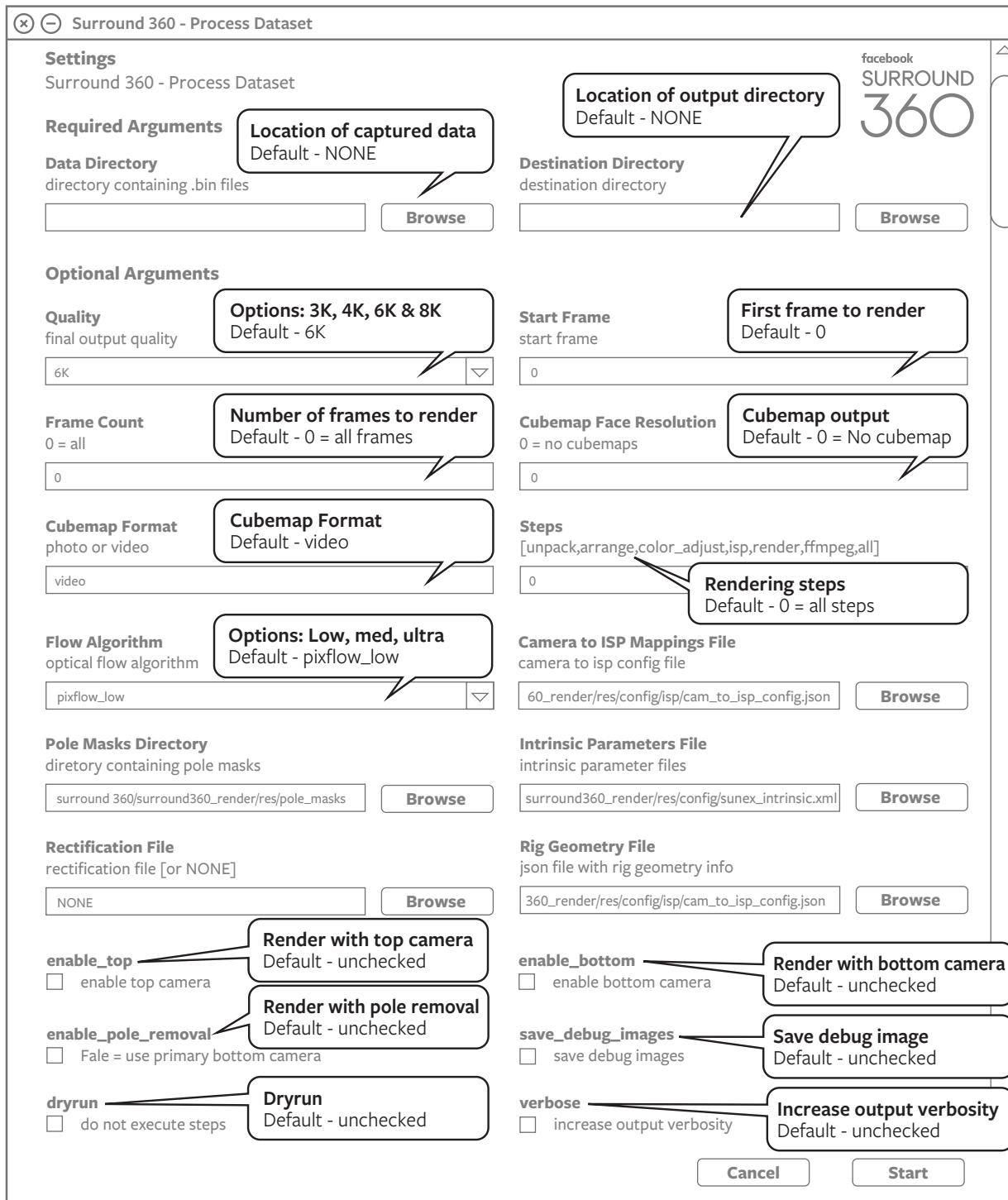
## 7.

### How to Render

#### To start the rendering process

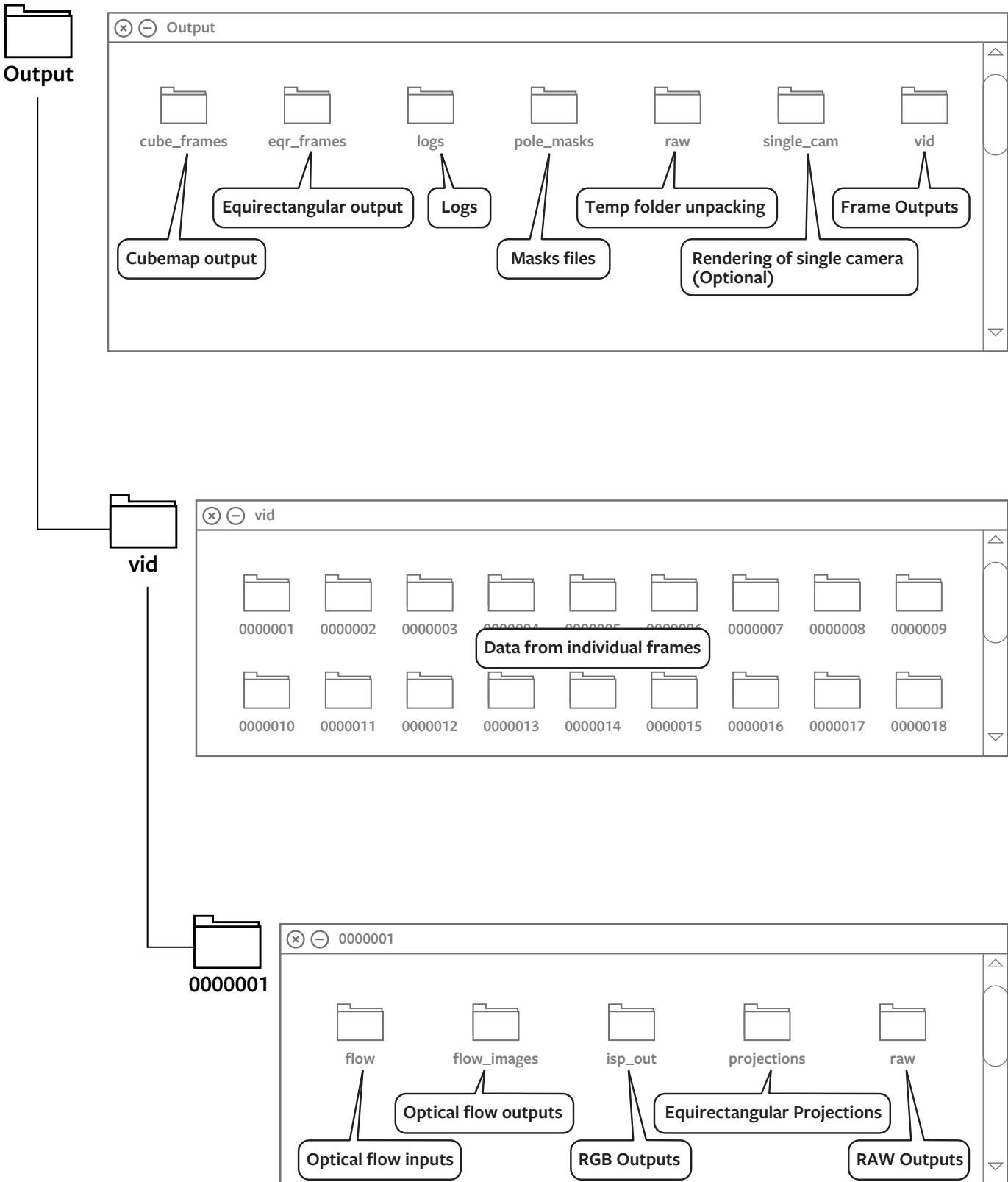
Run the following script

```
| cd /surround360/ surround360_render/ python scripts/run-all.py
```



# 6

## 8. Output Directory



# 7

Pro Tips

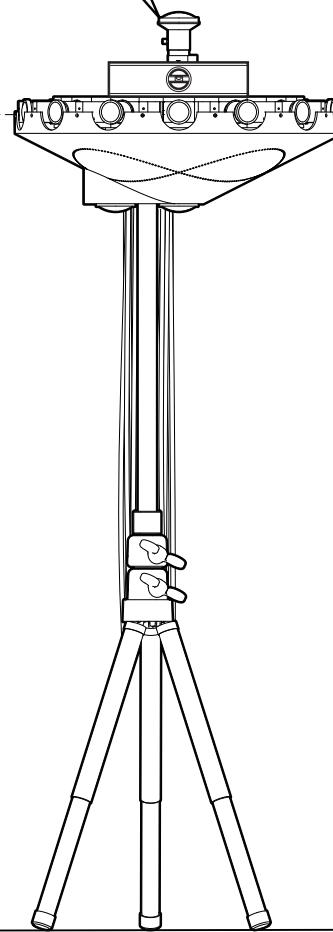
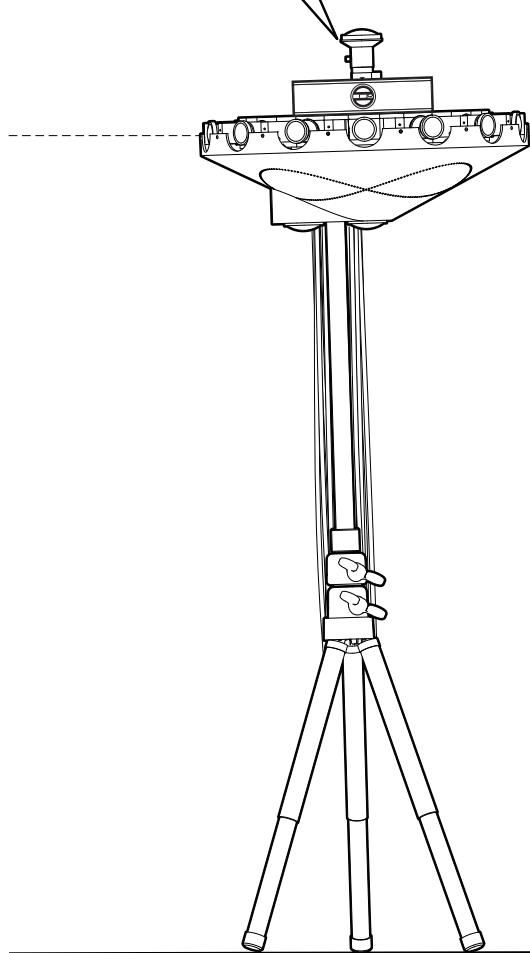
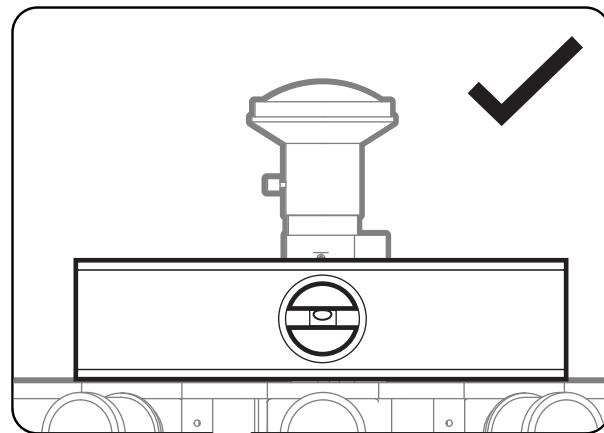
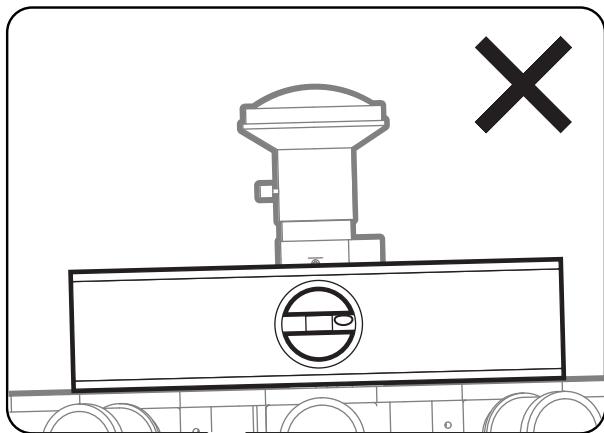
# 7

## 1.

### Level Camera for Level Horizon Line



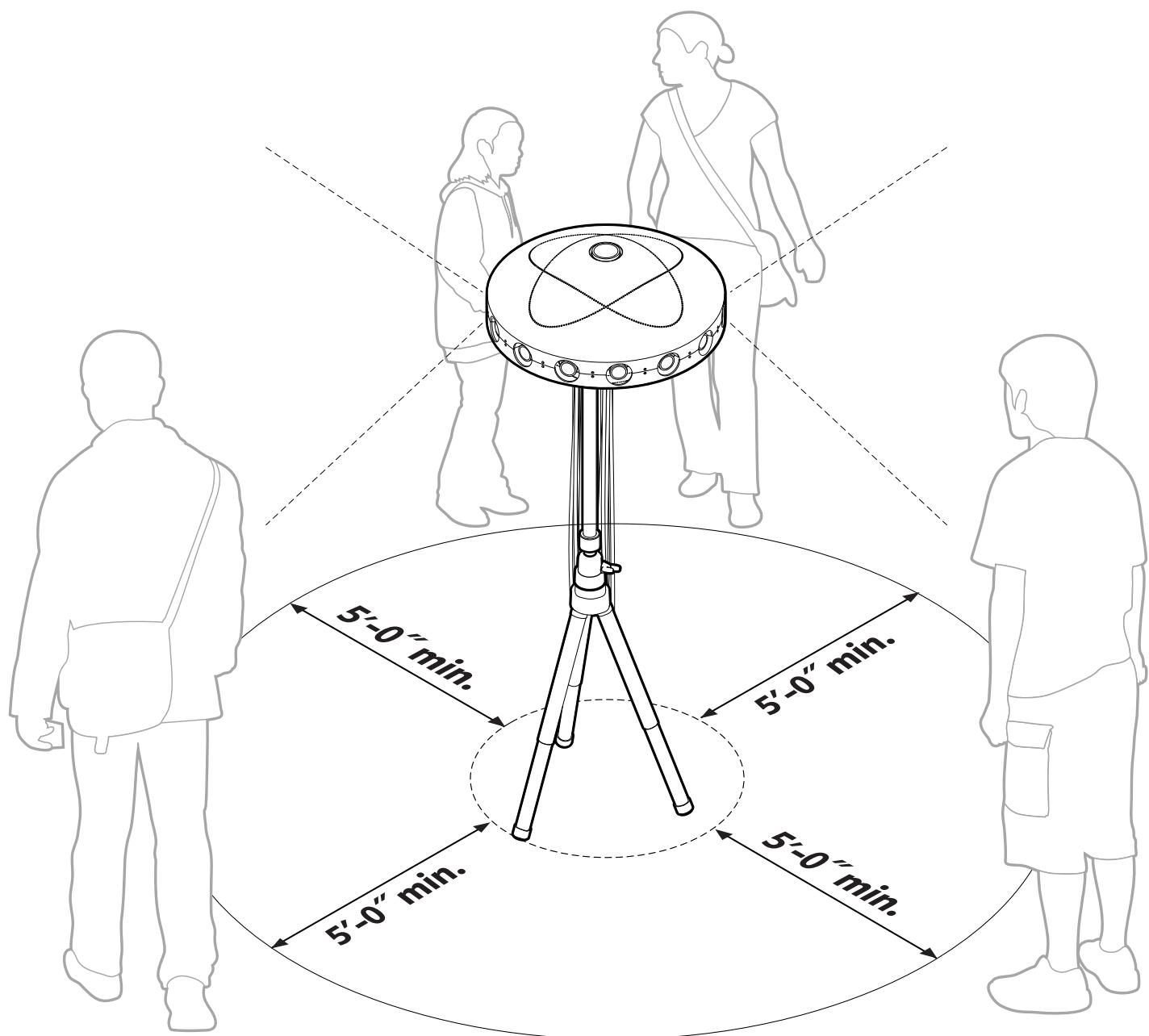
Remove top shell first!



# 7

## 2.

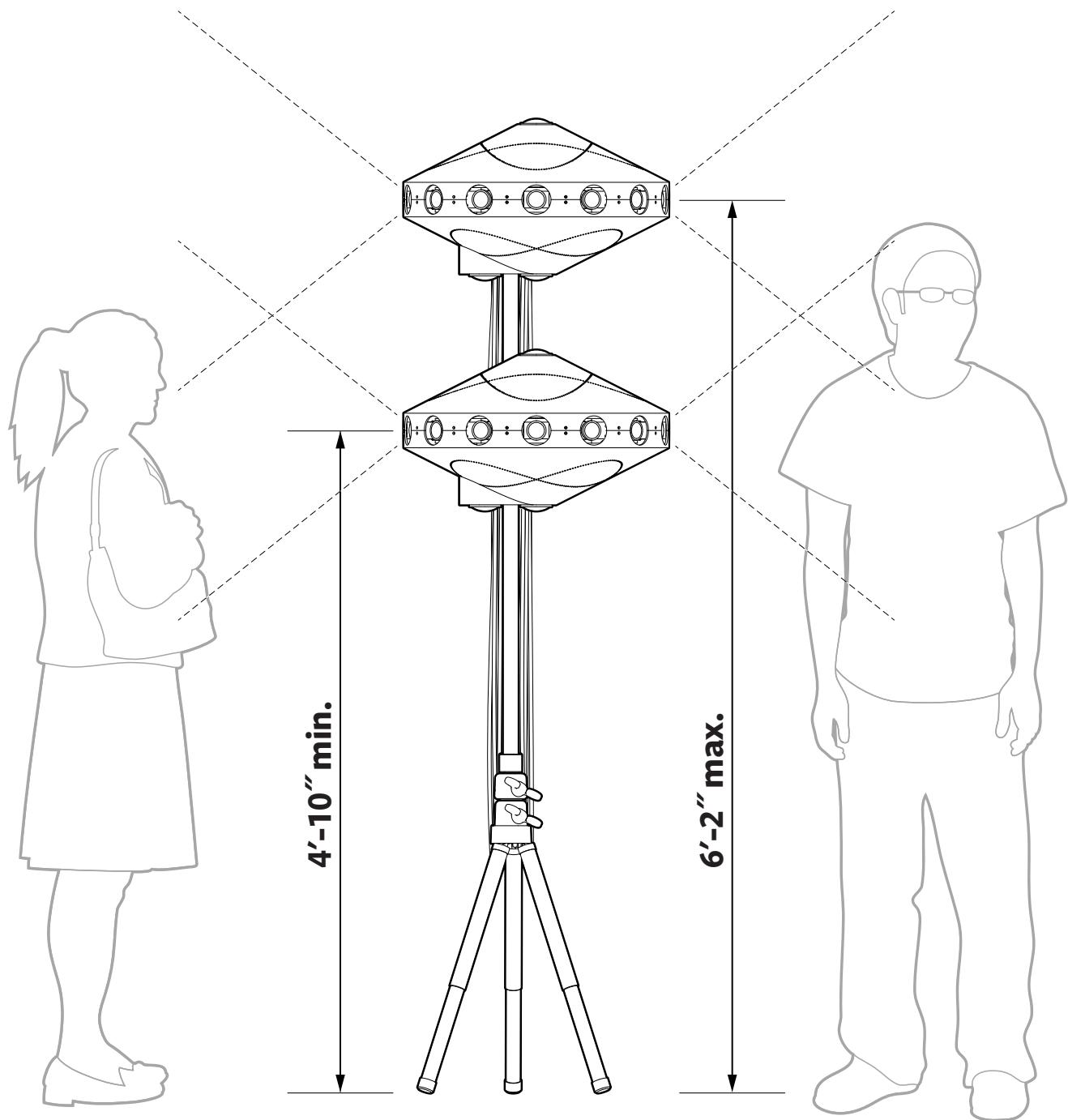
### Avoid Close Objects



# 7

## 3.

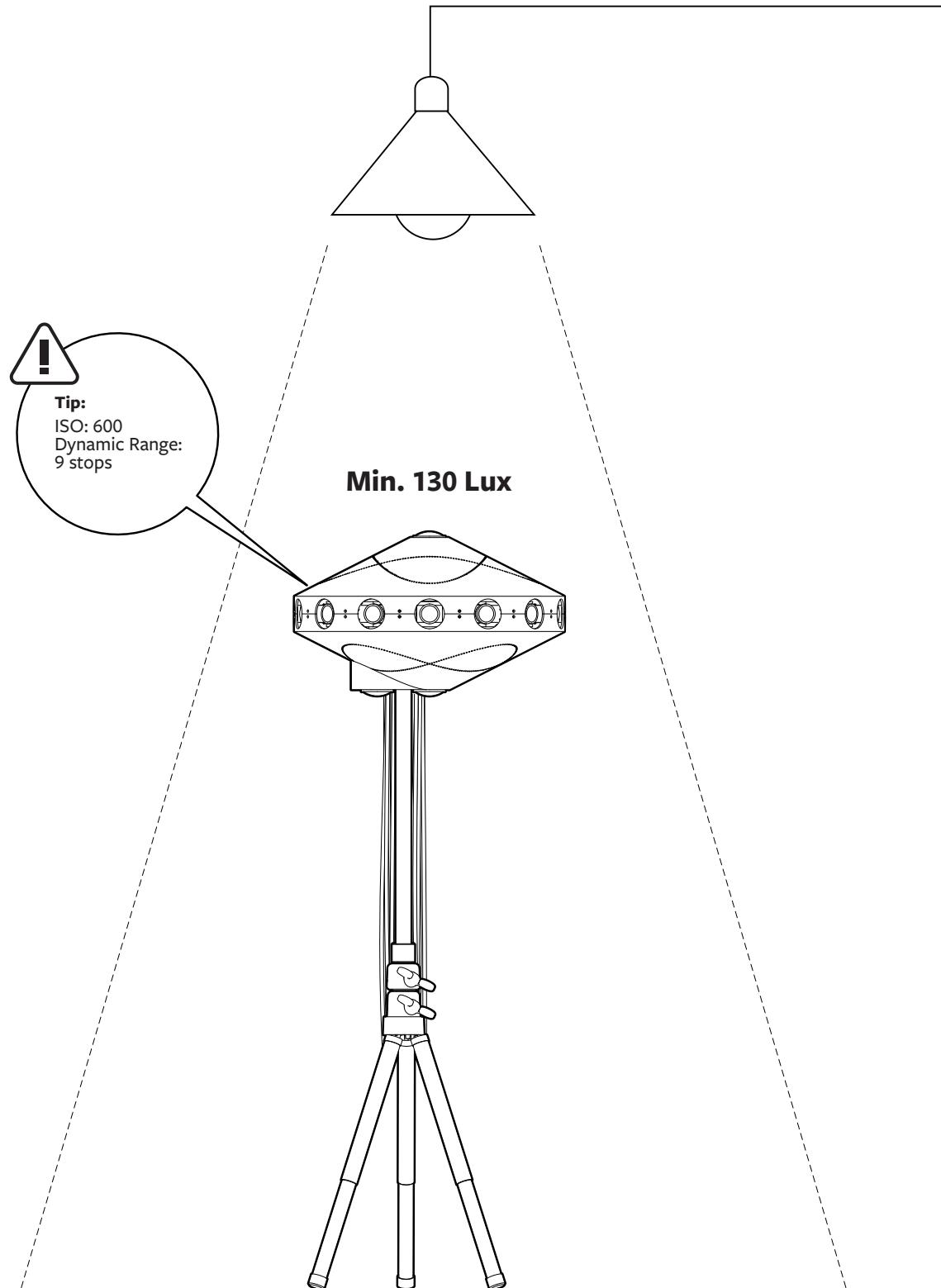
Be Aware of Camera Height for Better VR Experience



# 7

## 4.

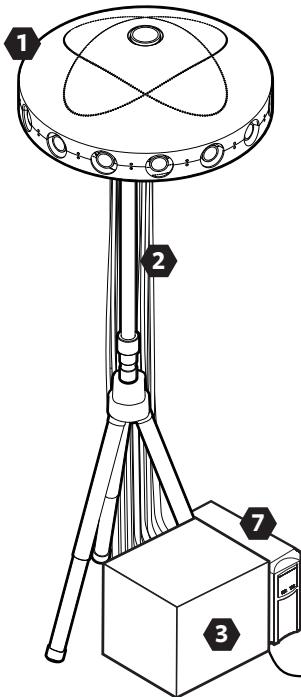
### Avoid Low Light Condition to Minimize Noise in Footage



# 7

## 5a.

### Placement of Surround 360

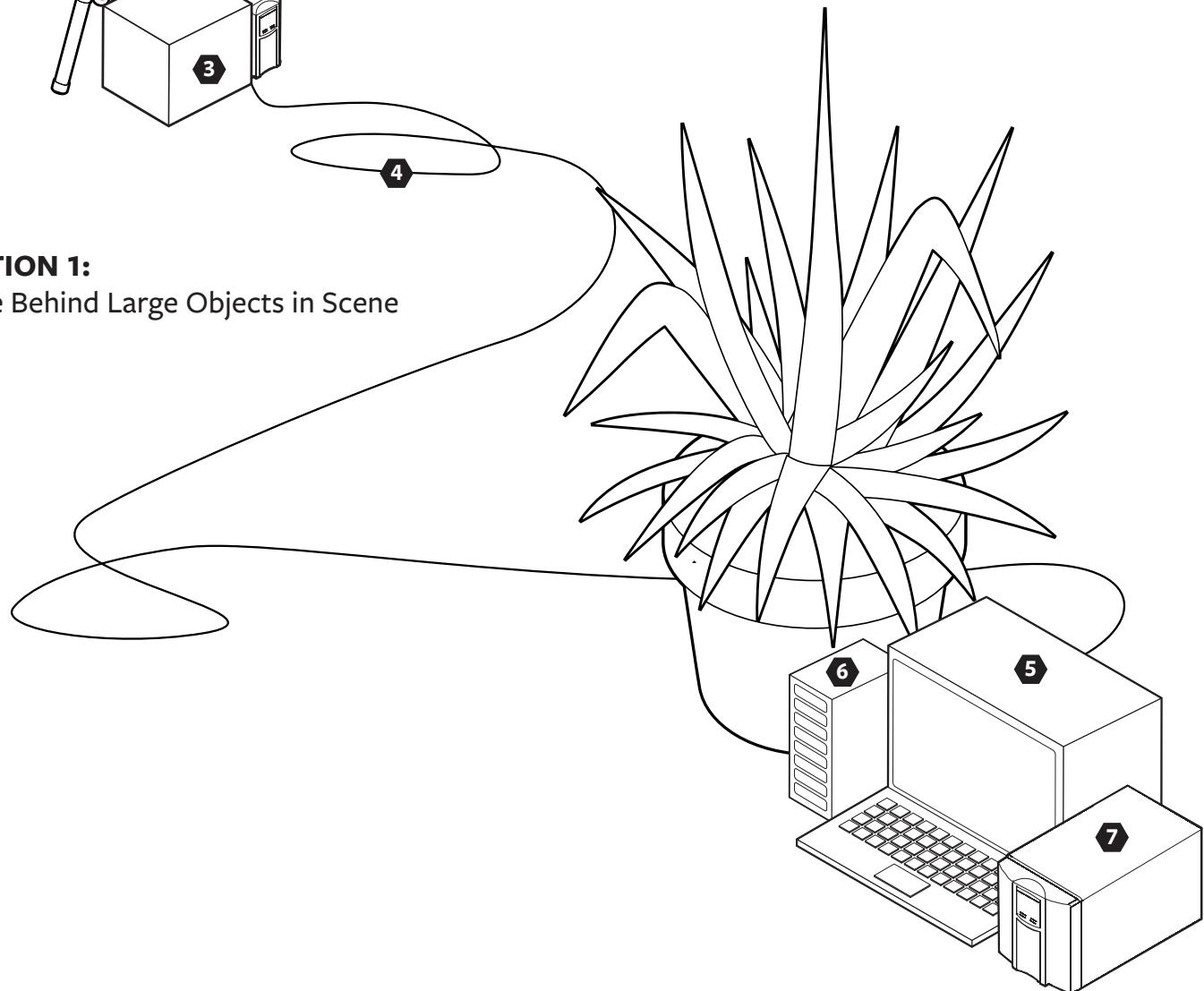


#### LEGEND

- 1 SURROUND 360
- 2 USB 3.0 Cables
- 3 Fiber Optic Breakout Box
- 4 Optical Cable
- 5 Computer
- 6 Raid Tower
- 7 Power Supply

#### OPTION 1:

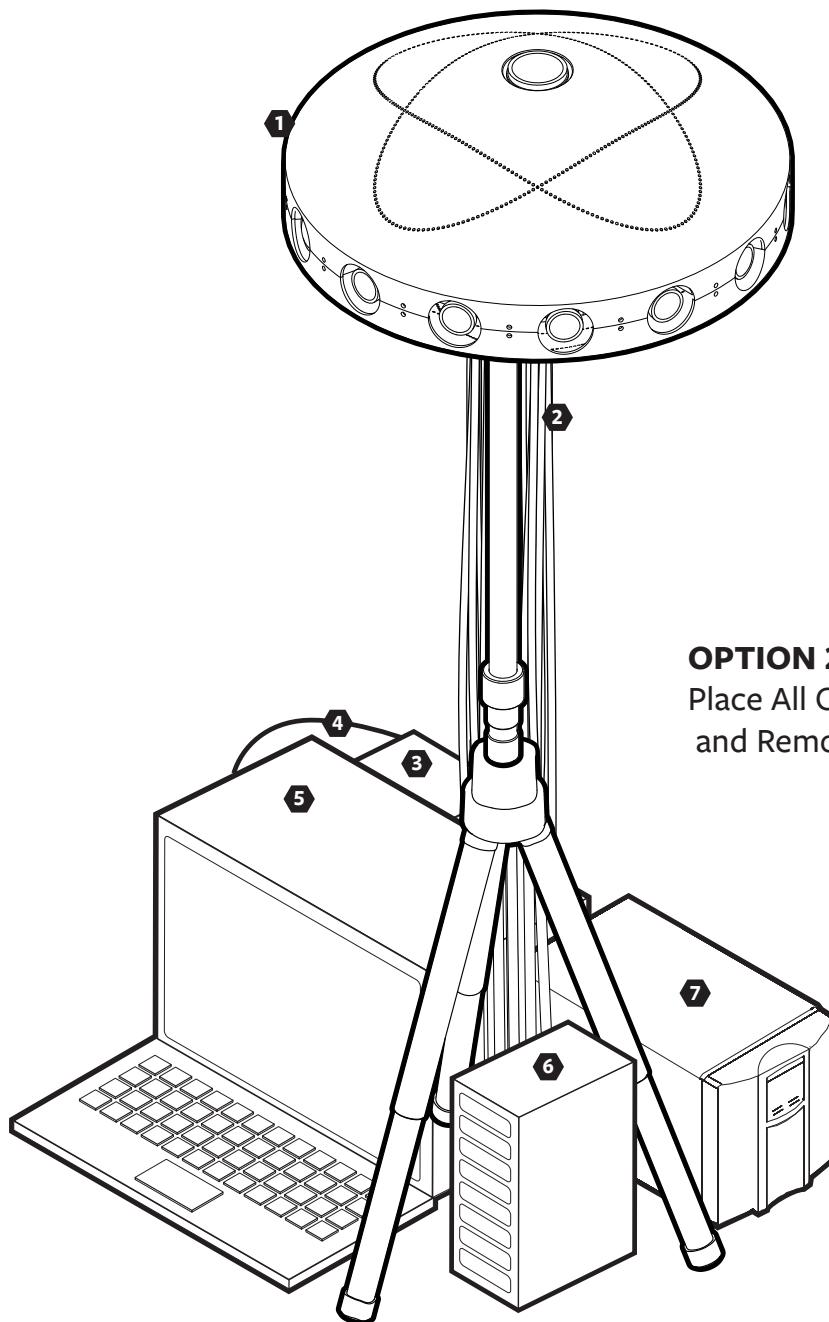
Hide Behind Large Objects in Scene



# 7

## 5b.

### Placement of Surround 360



#### LEGEND

- 1 SURROUND 360
- 2 USB 3.0 Cables
- 3 Fiber Optic Breakout Box
- 4 Optical Cable
- 5 Computer
- 6 Raid Tower
- 7 Power Supply

#### OPTION 2:

Place All Components Beneath Camera  
and Remove in Post-Production

# 8

## Camera Specifications

# 8

## 1. Specifications

Type	Spherical and stereoscopic video capture
Sensor Type	CMOS, global shutter
Sensor Name	CMOSIS CMV4000-3E5
Sensor Array	17 synchronized 1" sensors
Pixel Size	5.5 µm
ADC	10 bit
ISO	600
Dynamic range	9 stops
Coverage Area	Full spherical, 360 x 180 degrees
Stereoscopic Coverage	Centerline +/- 144(h), 77(v) degrees
Lens Angle of View	77 degrees diagonal (center), 185 degrees (top and bottom)
Relative Aperture	f/2.4 (wide-angle lens), f/1.8
Lens Mount	C mount
Resolution	8192 x 4096 per eye equirect * 2 = 8192 x 8192
Interface	USB 3.0
Capture Format	RAW
Capture Frame Rate	30 fps (max 60 fps)
Bandwidth	17 Gb/s (@ 30 fps)
Dimensions - camera only	460 x 460 x 307.65mm
Dimensions - with mount	460 x 460 x 796.60mm
Total Weight - camera only	16 kgs
Construction	Milled aluminum alloy & steel
Color	Black
Operating Temperature	0° to 50°C
Storage Temperature	-30° to 60°C
Operating Humidity	20% to 80% (no condensation)
Storage Humidity	20% to 95% (no condensation)
Power Consumption	350 watts max

# 8

## 2a.

### Bill of Material

#### CAMERA & LENSES

Point Grey Camera Body	GS3-U3-41C6C-C	17
Sunex Lens	DSL318	14
Fujinon Fisheye Lens	FE185Co86HA-1	3

#### MACHINED PART

Base Plate	FB360_V1_21	1
Top Plate	FB360_V1_22	1
Upright	FB360_V1_23	1
Camera Bracket	FB360_V1_24	1
Post	FB360_V1_25	1
Support Tube	FB360_V1_26	1
Adapter	FB360_V1_27	1
Shell Support	FB360_V1_28	14
Bottom Cover	FB360_V1_29	1
Top Cover	FB360_V1_30	1
Stop Nut	FB360_V1_31	1
Threaded Rod	FB360_V1_32	1
Lens Mounts/Barrels	FB360_V1_33	14

#### FASTENER

M3 X 6 SHCS 18-8	152
M3 Lockwasher	152
M6 X 12 FHCS 18-8	8
M6 X 50 FHCS 18-8	2
M6 X 35 SHCS 18-8	4
M3 X 8 BHCS	28
5/16-18 Flange Nut	1
M3 Jam Nut (Optional)	14
M2 x 20 PHCS (Optional)	10

# 8

## 2b.

### Bill of Material

#### COMPUTER

Ruggedized “Lunchbox” Computer	APOLLO-A1 MODEL	1
- Intel Core i7-5960X Haswell-E 8-Core 3.0 GHz LGA 2011-v3		
- GIGABYTE GA-X99P-SLI (rev. 1.0) LGA 2011-v3 Intel X99 Motherboard		
- 8GB DDR4 2400 288-PIN Memory ± (64GB of Memory Installed)		
- CPU COOLING FAN FOR LGA 2011-v3		
- 1GB NVIDIA PCI-EX16 VIDEO CARD		
- 700 WATT POWER SUPPLY		
- SAMSUNG 850 Pro Series 2.5" 128GB SSD		
- OPERATING SYSTEM - UBUNTU 14.04 LTS		
PCIe x8 Gen 3 Cable Adapter	OSS-PCIe-HIB38-x8-DUAL	1
PCIe 3.0 x 8 SAS RAID Adapter	ARC-1883X	1

#### FIBER OPTIC BREAKOUT BOX

PCIe Expansion Enclosure	OSS-PCIe3-ENCL-M-CUBE3-8	1
Expansion Backplane	OSS-BP-452	1
PCIe x8 Gen 3 Cable Adapter	OSS-PCIe-HIB38-x8-DUAL	1
USB 3.0 Expansion Card	UE-1008 / UE-1004	5
Shunt Jumper	390088-1	1

#### RAID TOWER

8-bay 12G SAS RAID Tower	ARC-4038	1
1TB SSD	MZ 7KE1ToBW	8

#### CABLES

HR25 GPIO connector	FB360_V1_34	17
USB3 type A to micro B locking cables		17
External 4x HD Mini-SAS Cable	SFF-8644 to SFF-8644	2
PCIe x8 Active Optical Cable	OSS-PCIe3-CBL-ACT-x8-50M-1x	1





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