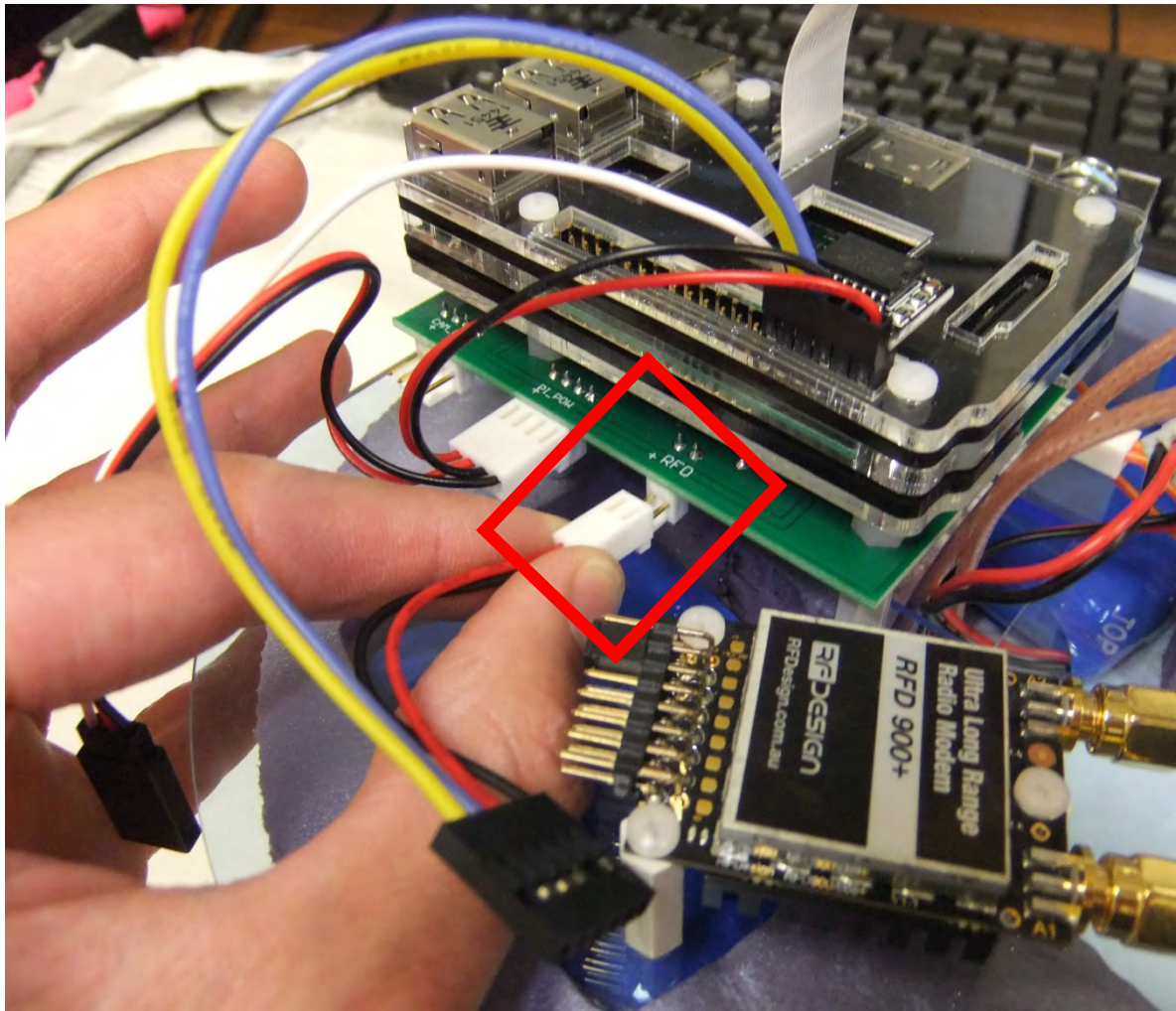


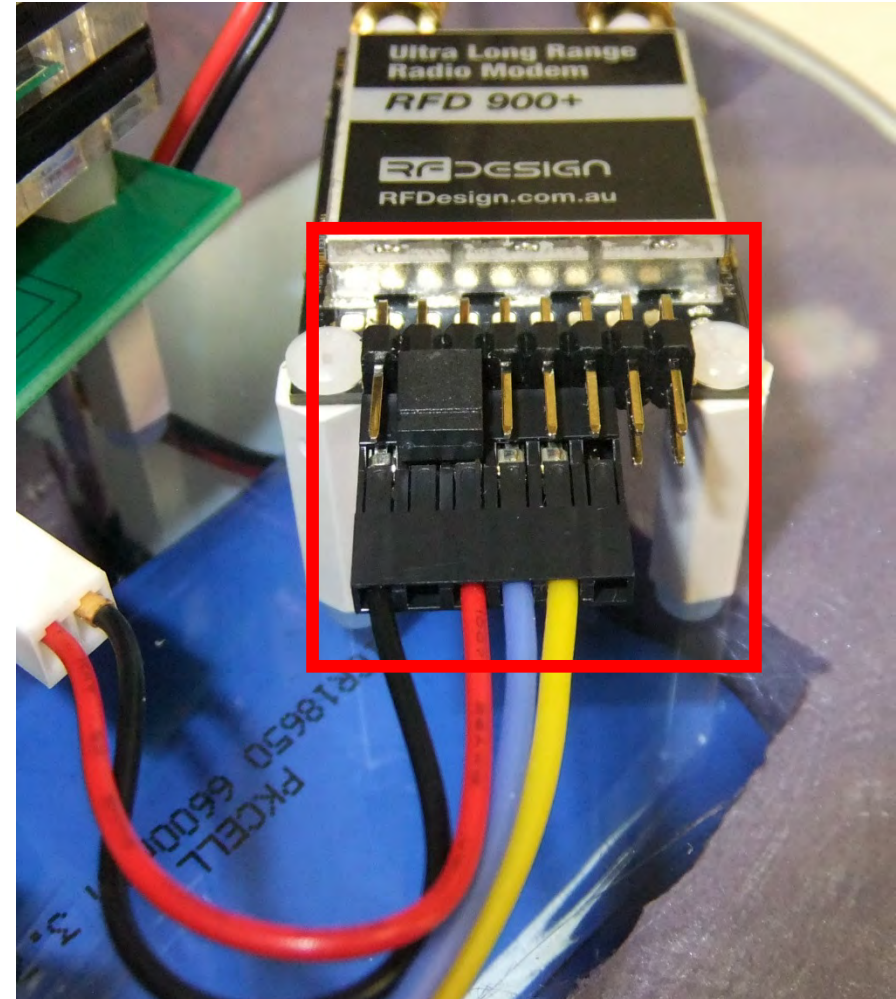
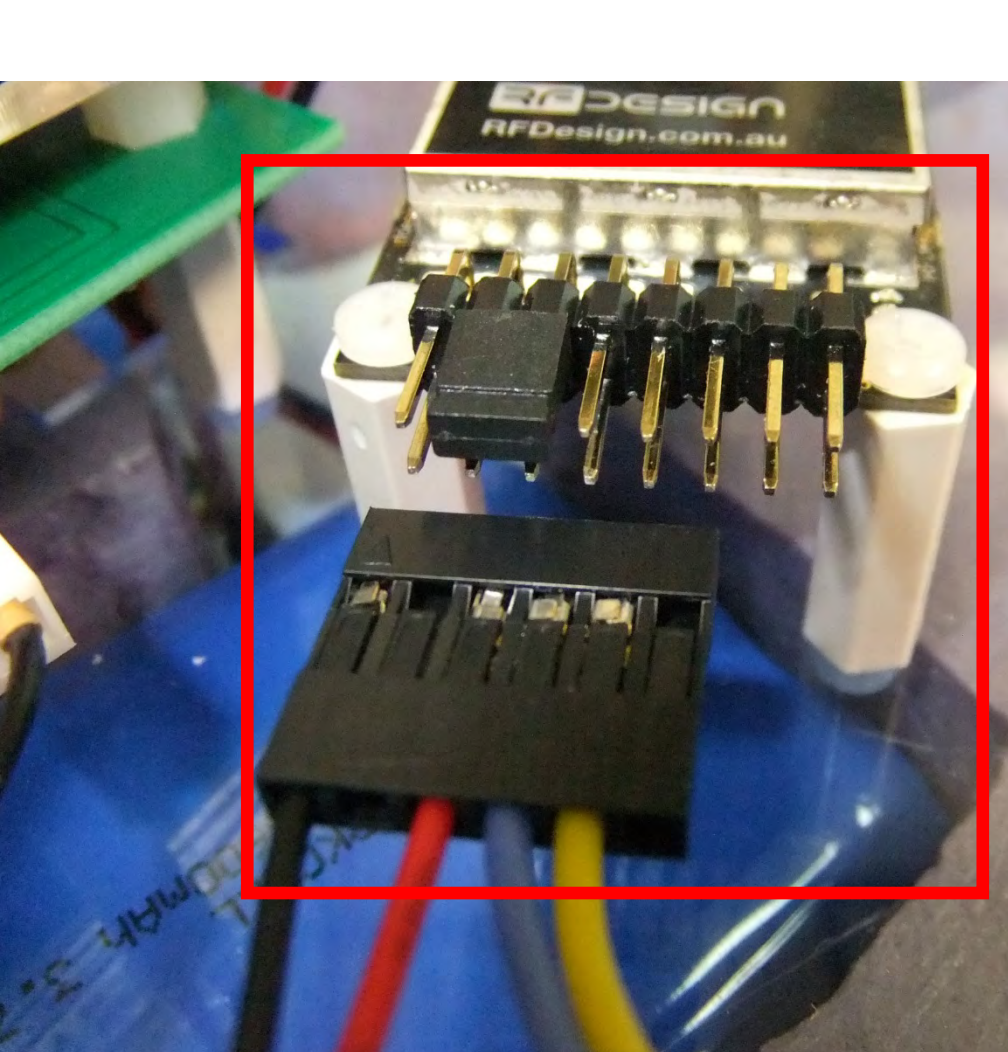
Building the Still Image Payload: Connecting RFD 900+ Modem Power

STEP 26 **Connect the RFD Power to the Power board (2 pin).**



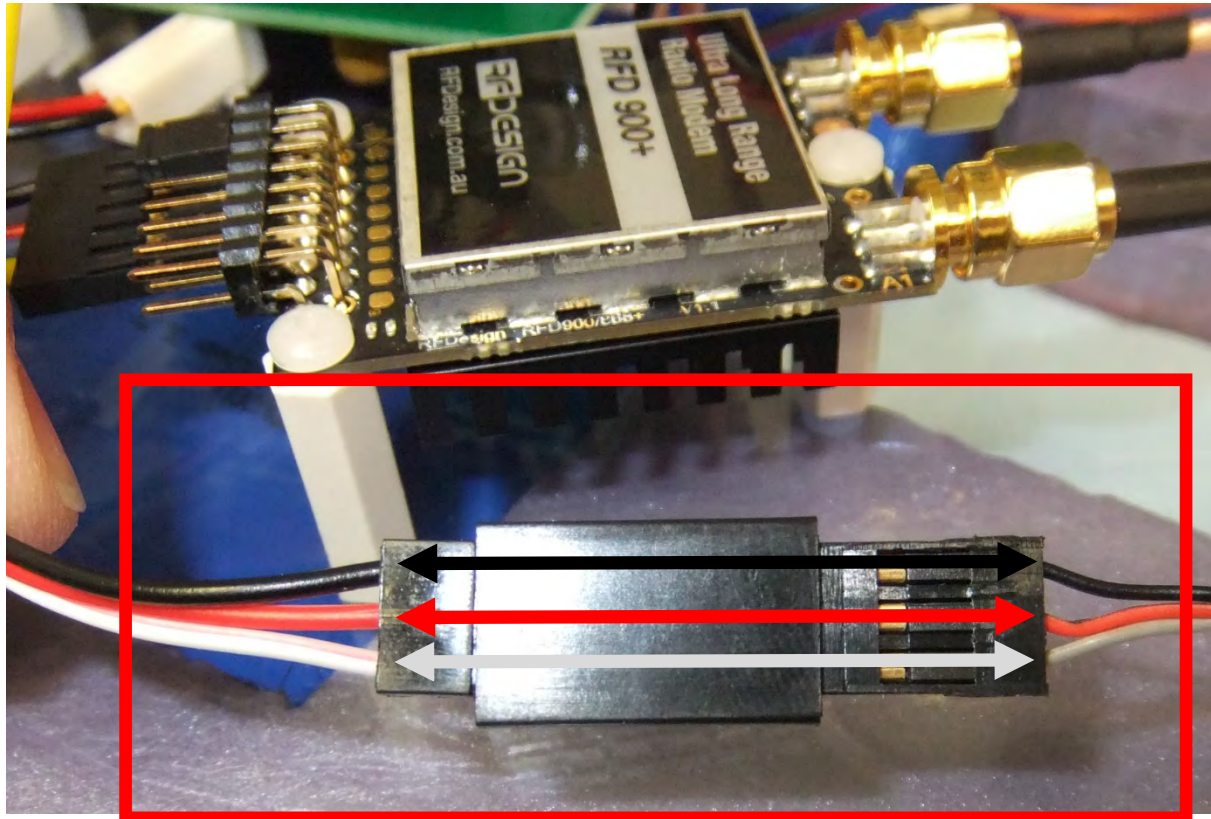
Building the Still Image Payload: Connecting RFD 900+ Modem Power

Connect the RFD Connector:



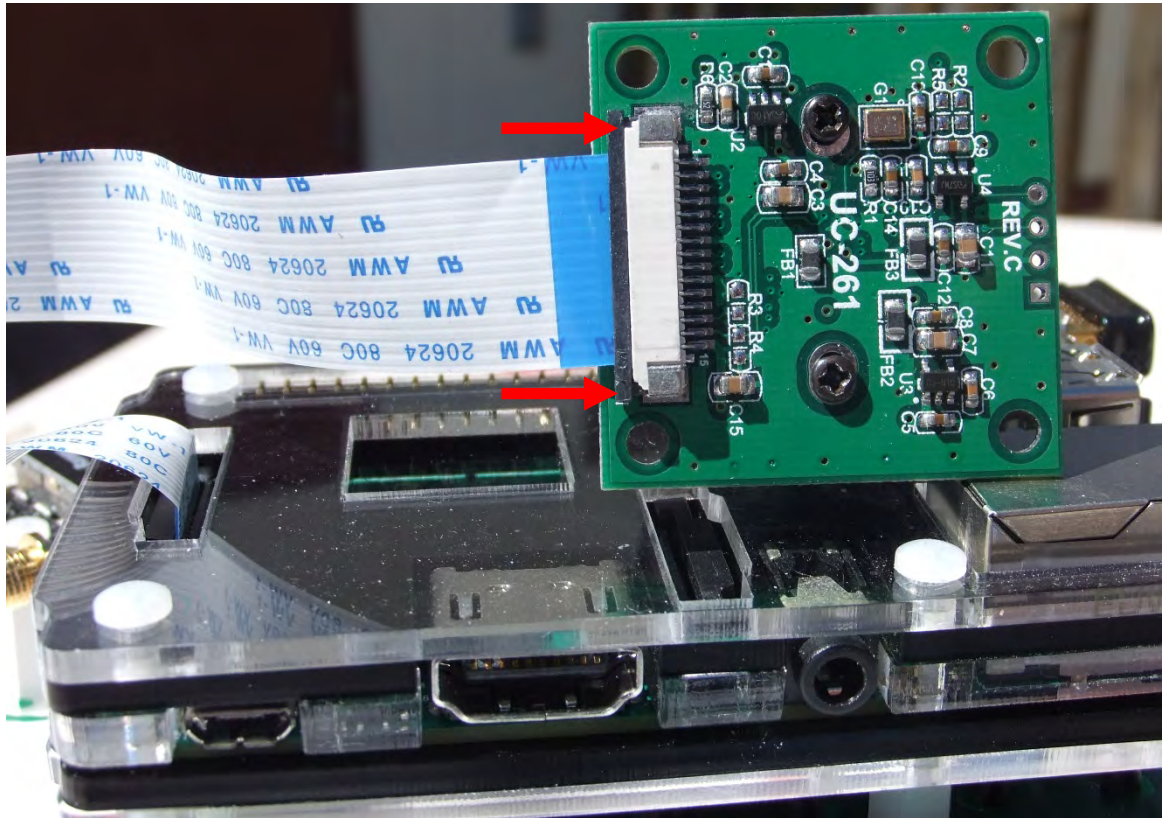
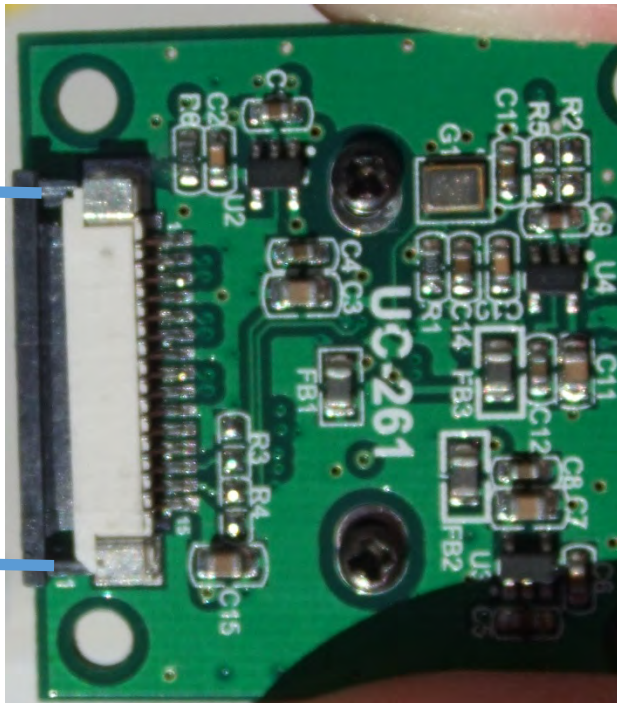
Building the Still Image Payload: Connecting Camera Motor Servo

Connect the pi camera motor servo by matching the colored wires.



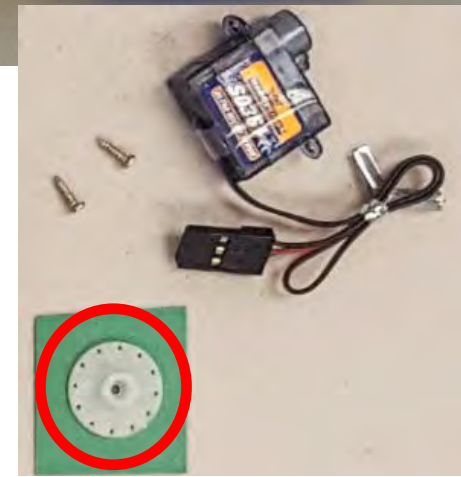
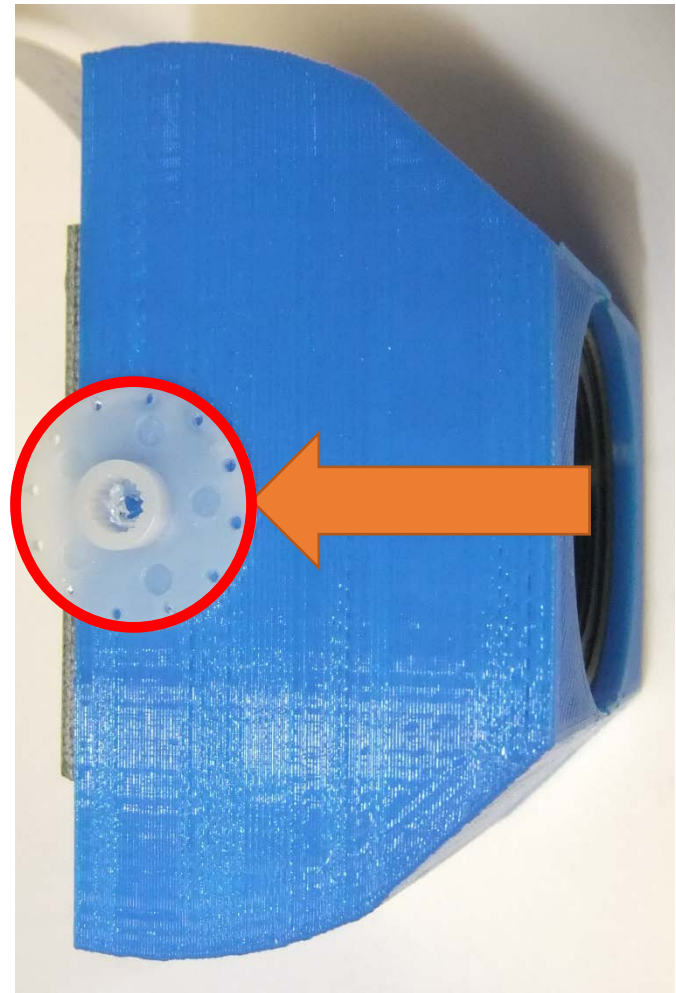
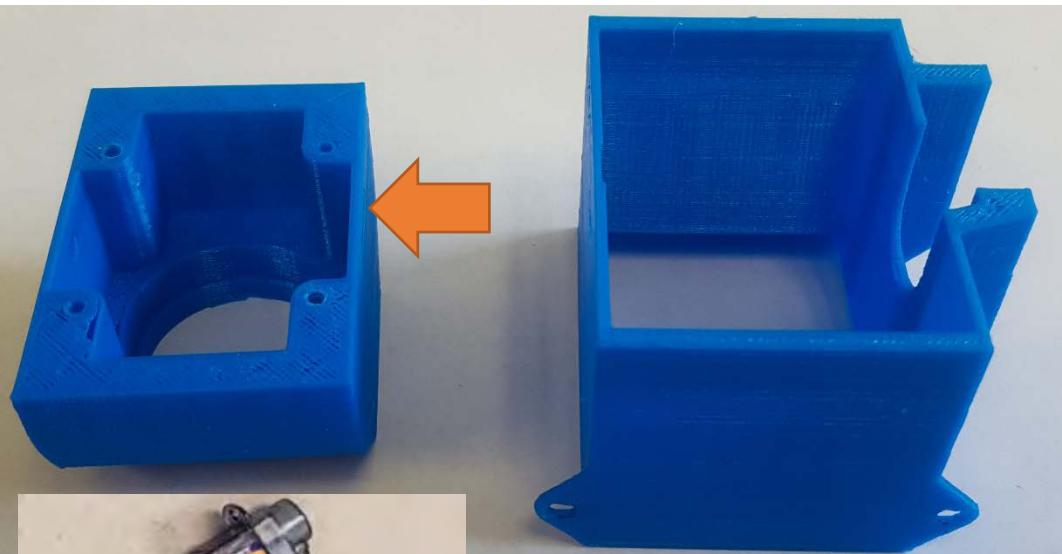
Building the Still Image Payload: Connecting Pi Camera

Unlock the ribbon cable connector on the back of the Pi Camera by GENTLY (THESE WILL BREAK IF YOU ARE NOT CAREFUL!) **pulling the black lock out**. Insert the ribbon cable such that the exposed pins face the PCB as shown below. **Push the black lock in** to lock the ribbon cable into place.



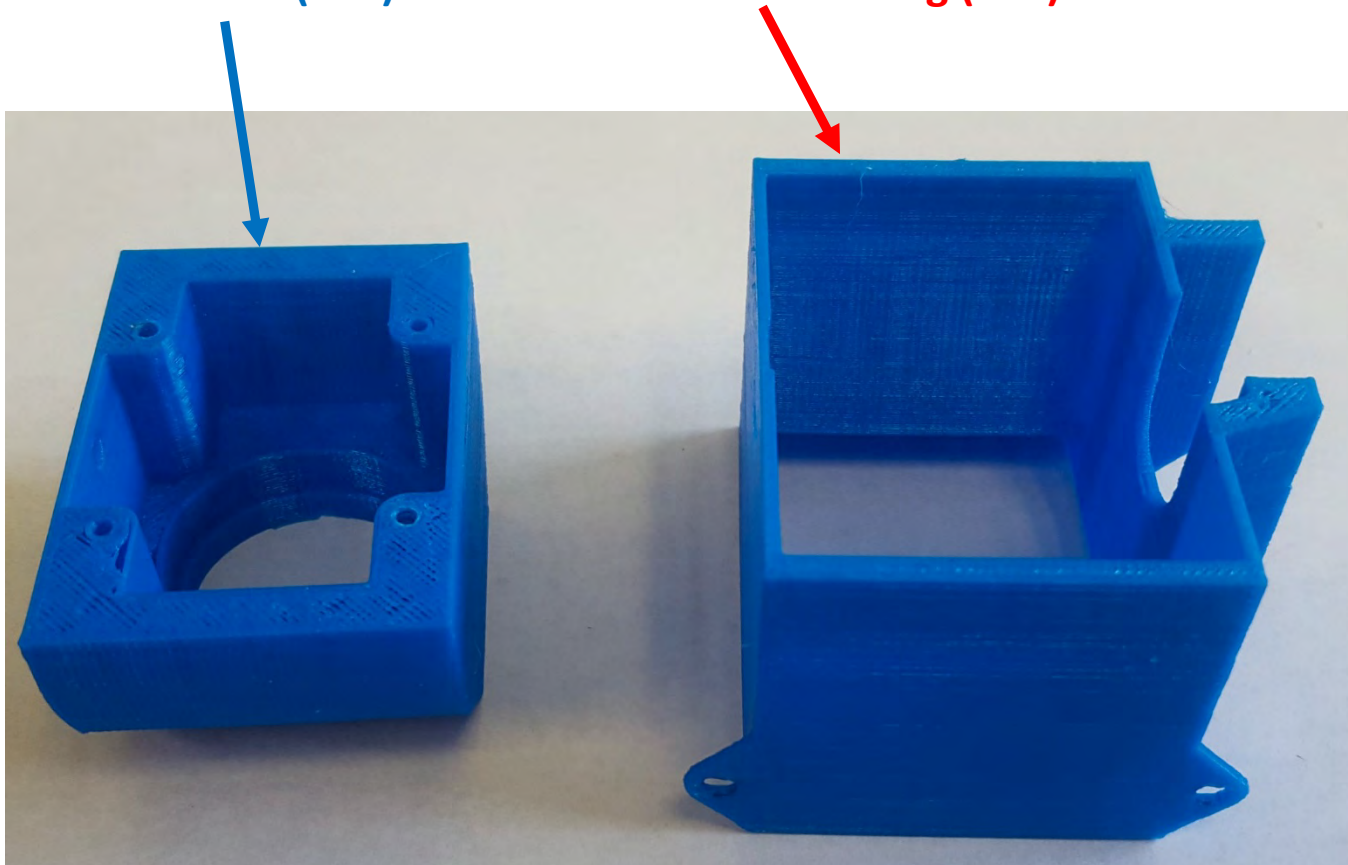
Building the Still Image Payload: Pi Camera Housing Prep

If you have not already done so, glue the **servo mounting wheel** to the side of the camera housing **HERE**, making sure to line up the hole in the mounting wheel with the hole in the side of the camera Housing.



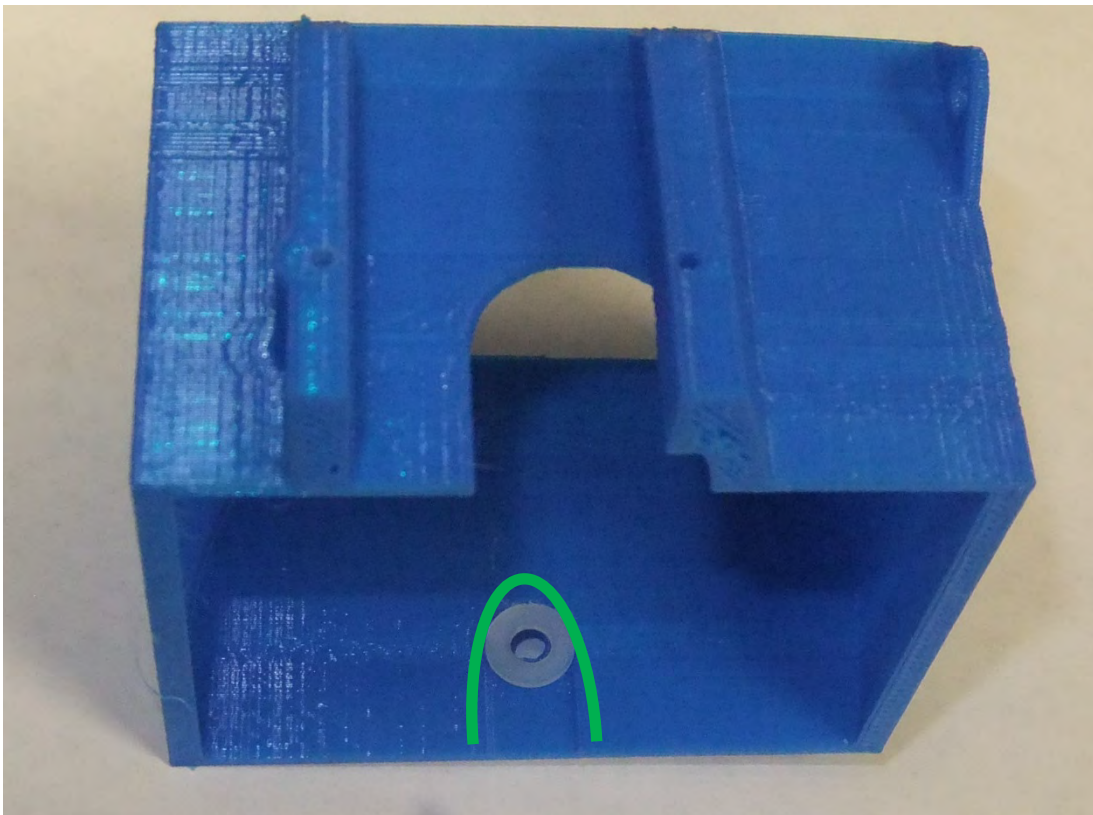
Building the Still Image Payload: Pi Still Camera Housing

You have two 3D printed components for mounting your Pi still camera: The **camera mount (E27)** and **camera mount housing (E27)**.



Building the Still Image Payload: Pi Still Camera Housing

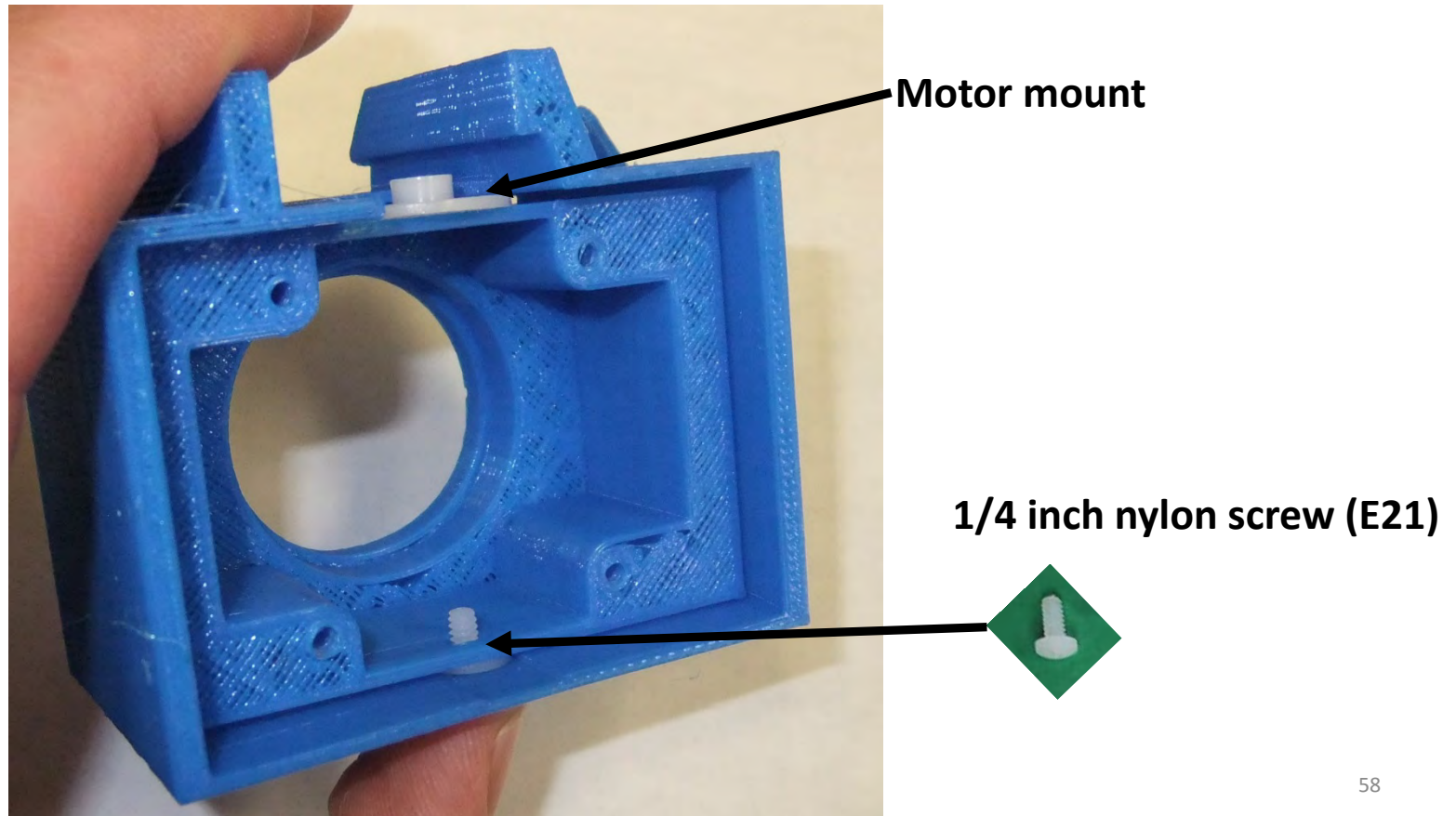
Place the **METAL washer (E31)** in the **U shaped indent** in the camera mount housing.



NOTE! A nylon washer is shown but you will use a METAL washer for the build. If you don't have a metal washer, please ask for one from one of the helpers.

Building the Still Image Payload: Pi Still Camera Housing

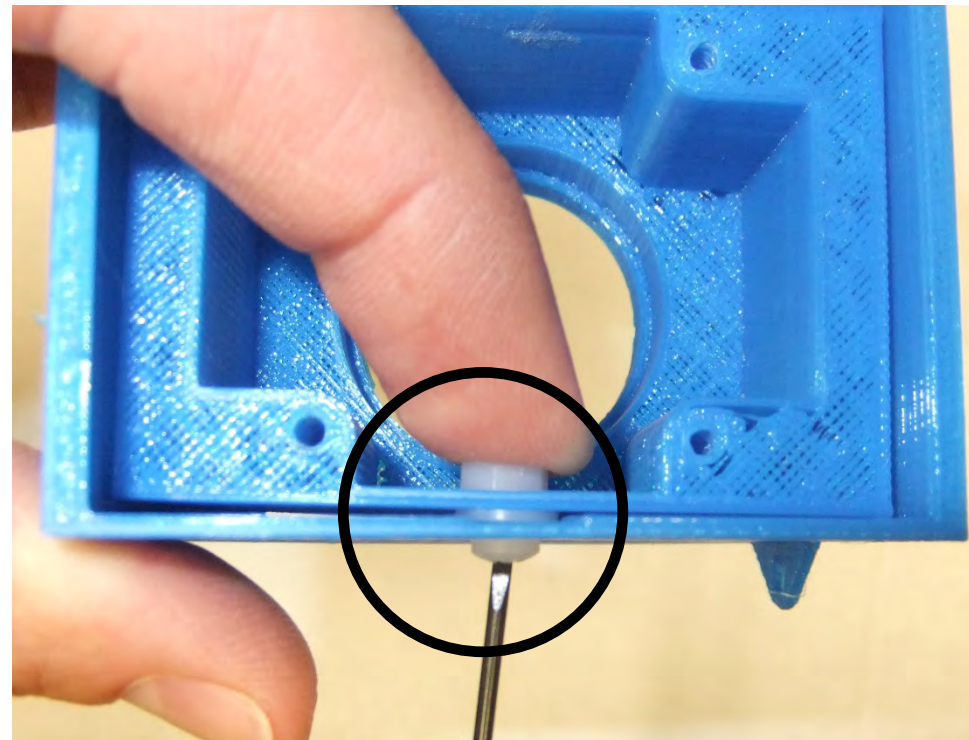
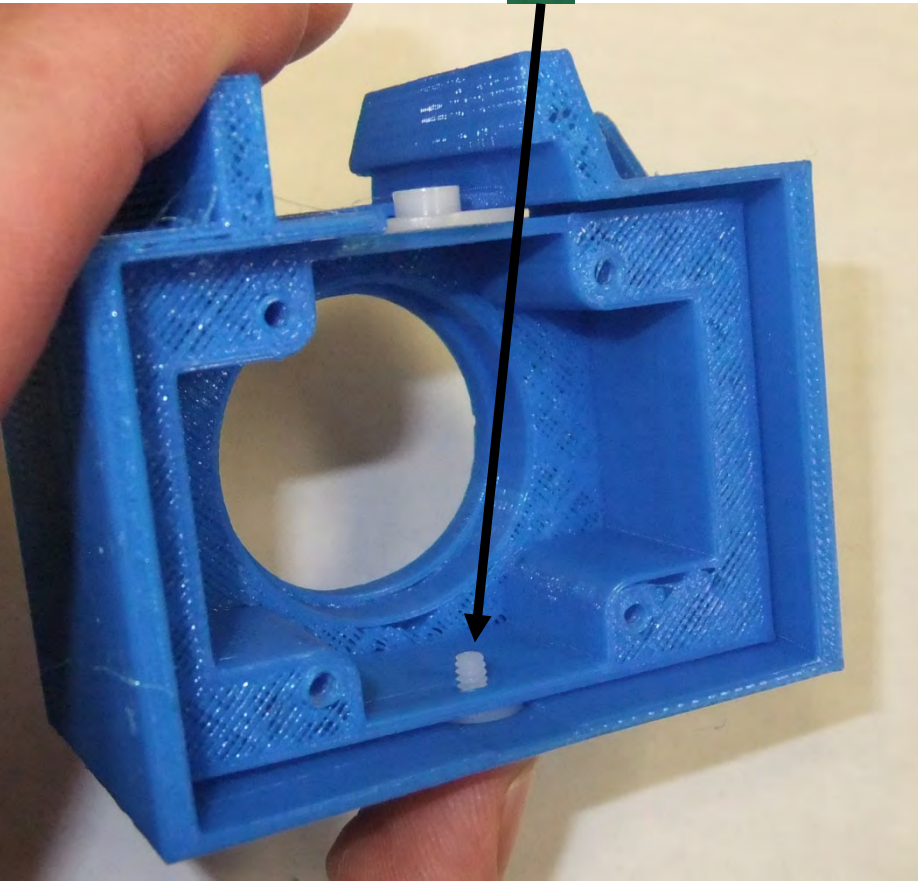
Slide the camera mount into the camera mount housing being careful not to dislodge the washer. Next, carefully slide a **1/4 inch nylon screw (E21)** through the hole of the housing/mount opposite the motor mount and hold in place with your thumb.



Building the Still Image Payload: Pi Still Camera Housing

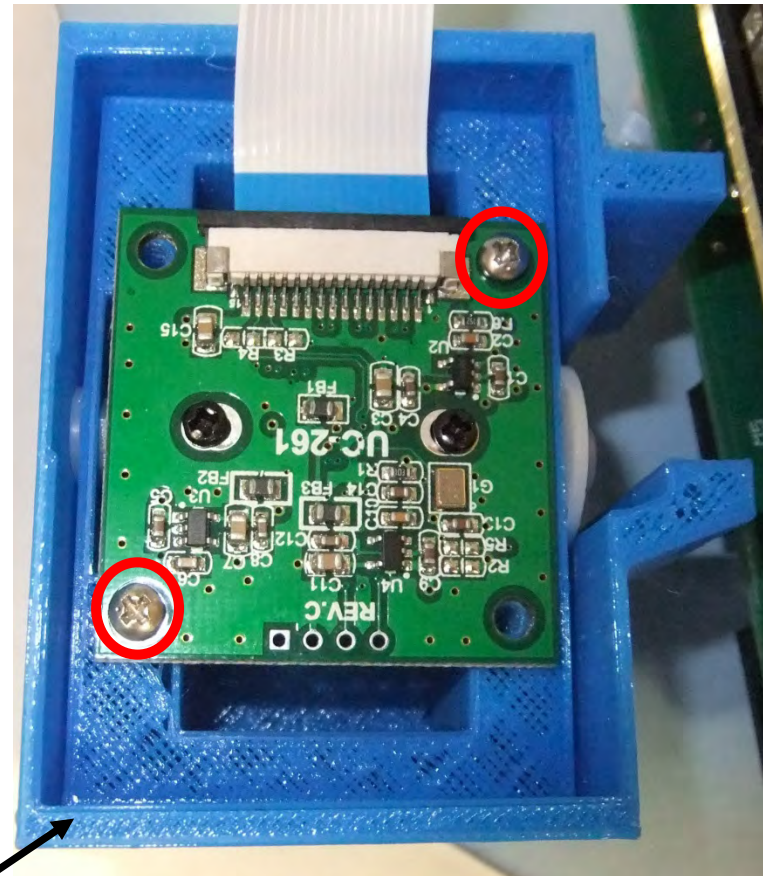
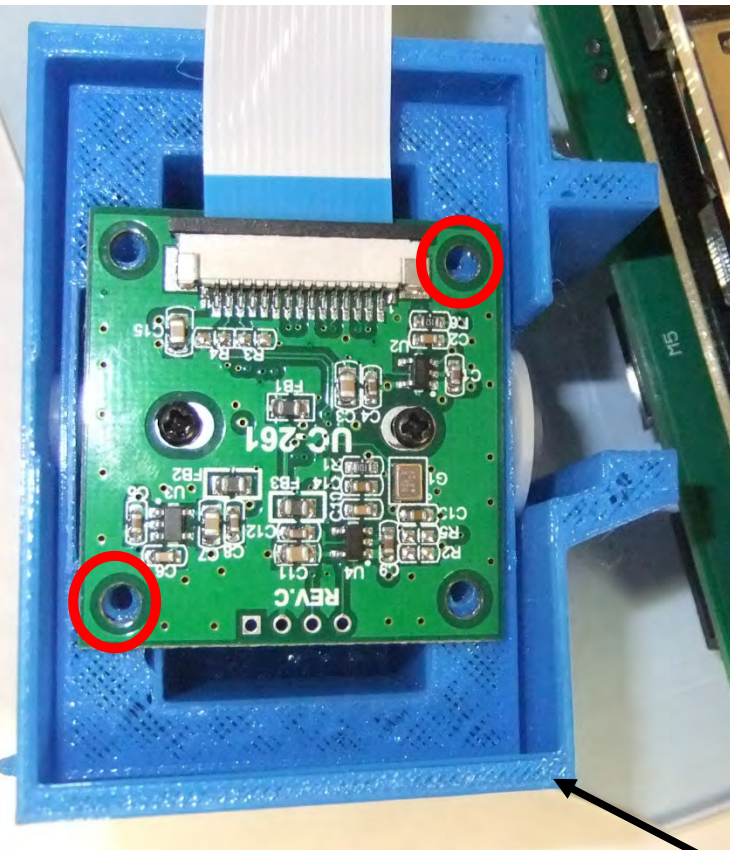
Place a **nylon nut (E26)** on the screw and tighten until snug.

 nylon nut (E26)



Building the Still Image Payload: Pi Still Camera Housing

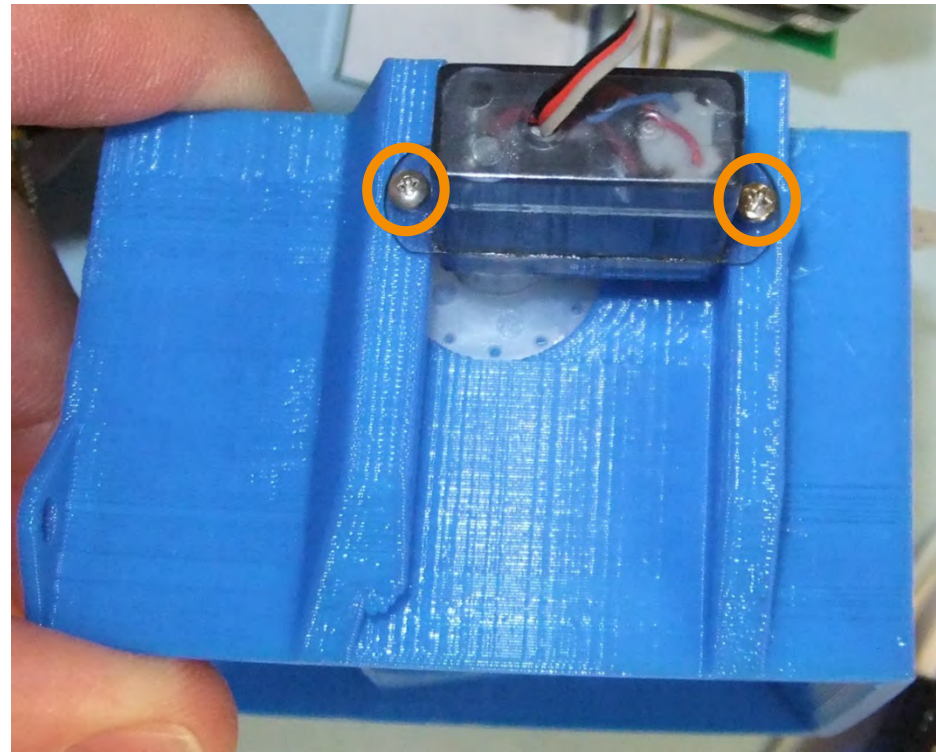
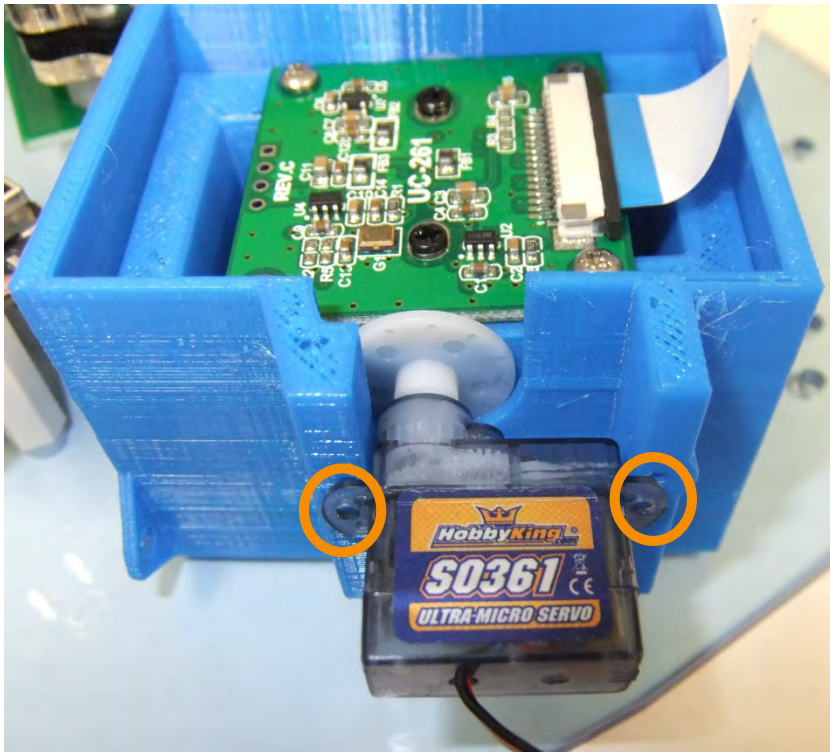
Place the Pi video camera into the camera mount and **use two 3/16 inch self tapping screws (E28) to hold the camera in place in the two positions shown below.**



BASE

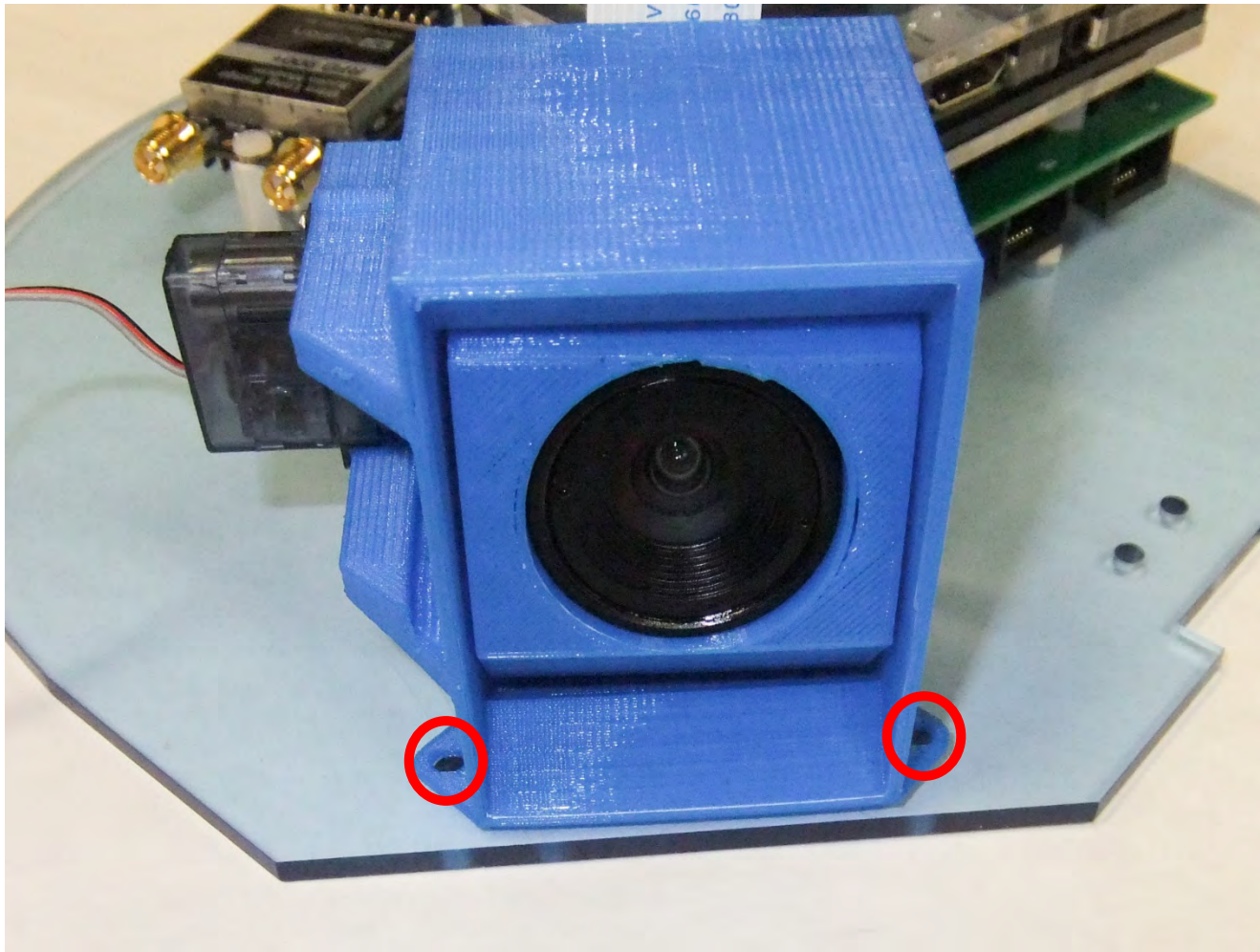
Building the Still Image Payload: Pi Still Camera Housing

Gently insert the motor into the motor mount disk. Take the **two 1/4 inch metal screws (E32)** and secure the motor to the camera mount housing in the pre-drilled holes.



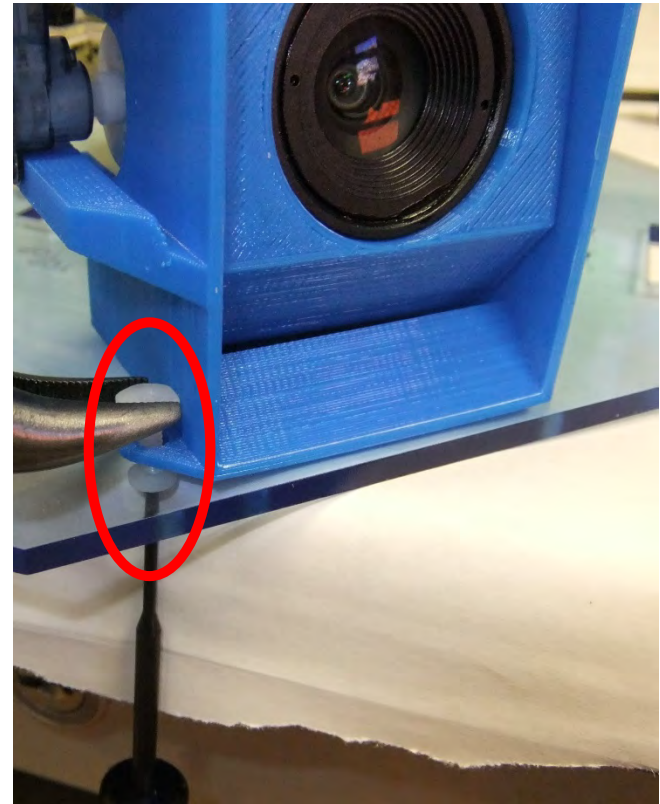
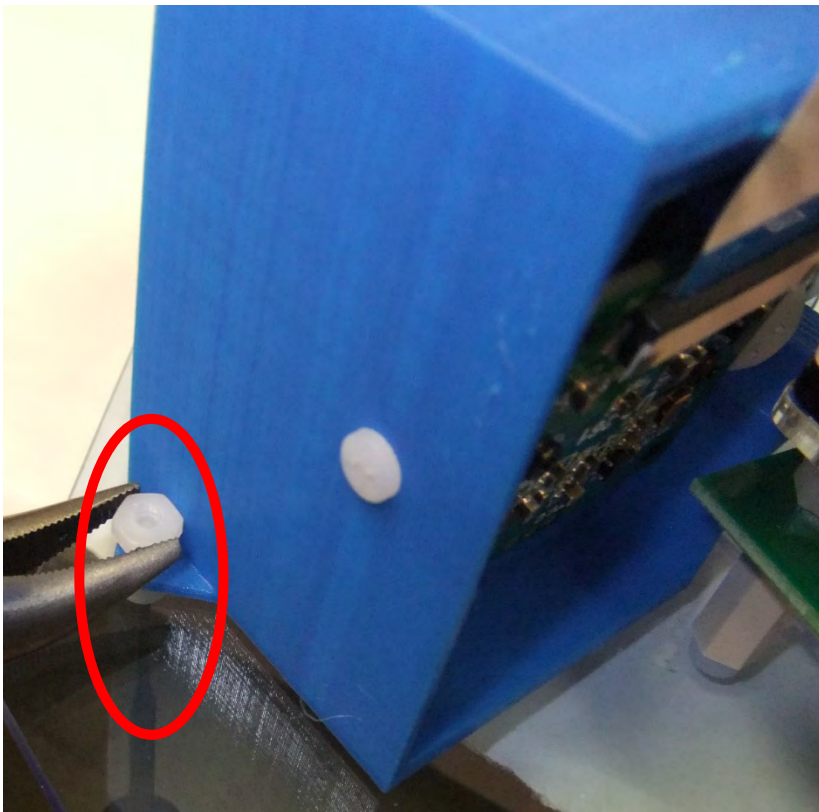
Building the Still Image Payload: Pi Still Camera Housing

Place the camera mount housing assembly on the acrylic base plate and secure using two 3/8 inch nylon screws (E22) and two nylon nuts (E26) **HERE**.



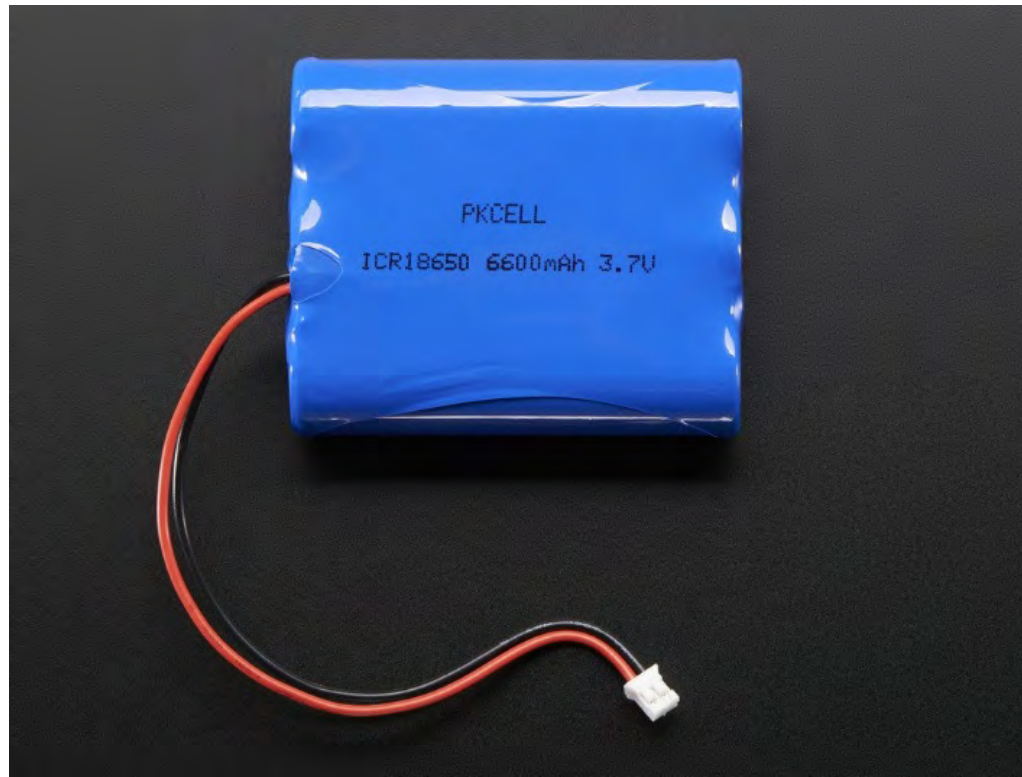
Building the Still Image Payload: Pi Still Camera Housing

Place the camera mount housing assembly on the acrylic base plate and secure using two 3/8 inch nylon screws (E22) and two nylon nuts (E26) **HERE**.



Your 3.7V 6600mAh Lithium Ion Battery Pack

Taking care of, using, and safety of your 3.7V Lithium battery packs.



Safety Notes

- Each cell can provide **0.5C** of current (1.1 A per) so all together the peak current you can draw is over 3.3 Amps. Note that these batteries are not designed to sustain such high loads, we suggest keeping any constant current draw under 0.2C or 1.3A.
- The packs come with color coded wires, and now they come with a JST 2-pin cable attached for use with our chargers! Because they have a genuine JST connector, not a knock-off, the cable won't snag or get stuck in a matching JST jack, they click in and out smoothly. The cables are rated for 2A so if you use them keep that in mind.
- The included protection circuitry keeps the battery voltage from going too high (over-charging) or low (over-use) which means that the battery will cut-out when completely dead at about 3.0V. However, even with this protection **it is very important that you only use a Li-Ion/Li-Poly constant-voltage/constant-current charger to recharge them and at a rate of 0.25C (1.5A) or less.**
- Like most lithium-ion packs, the batteries we sell do not have thermistors built in. This is why we suggest charging at 0.2C or even less - 1A max in this case. Of course, you can charge at a lower rate - it'll just take a little longer to fill up.
- Do not use a Ni-MH/Ni-Cad/lead-acid charger! Also, do not abuse these batteries, do not short, bend, crush or puncture. **Never charge or use unattended. Always inspect batteries and surrounding circuitry constantly for any damage, loose wiring, or possibility of short circuits.** As with all Lithium ion polymer batteries and with any power source - they should be used by experts who are comfortable working with power supplies

To prevent potential leaking, overheating or explosion of batteries please be advised to take the following precautions:

WARNINGS!

- Do not immerse the battery in water or seawater, and keep the battery in a cool dry environment during stand-by periods.
- Do not use or leave the battery near a heat source such as fire or heater.
- When recharging, use the battery charger specifically for that purpose.
- Do not reverse the positive (+) and negative (-) terminals.
- Do not connect the battery to an electrical outlet.
- Do not dispose of the battery in fire or heat.
- Do not short-circuit the battery by directly connecting the positive (+) and negative (-) terminal with metal objects such as wire.
- Do not transport or store the battery together with metal objects such as necklaces, hairpins etc.
- Do not strike or throw the battery against any hard surface.
- Do not directly solder to the battery and pierce the battery with a nail or other sharp object.
- The outer metal conductor should never contact the aluminum laminate film, especially with electrification, since this can result in “black spots ”and/or gas release (swelling).
- Do not use sharp things to hit the battery.

To prevent potential leaking, overheating or explosion of batteries please be advised to take the following precautions:

CAUTIONS!

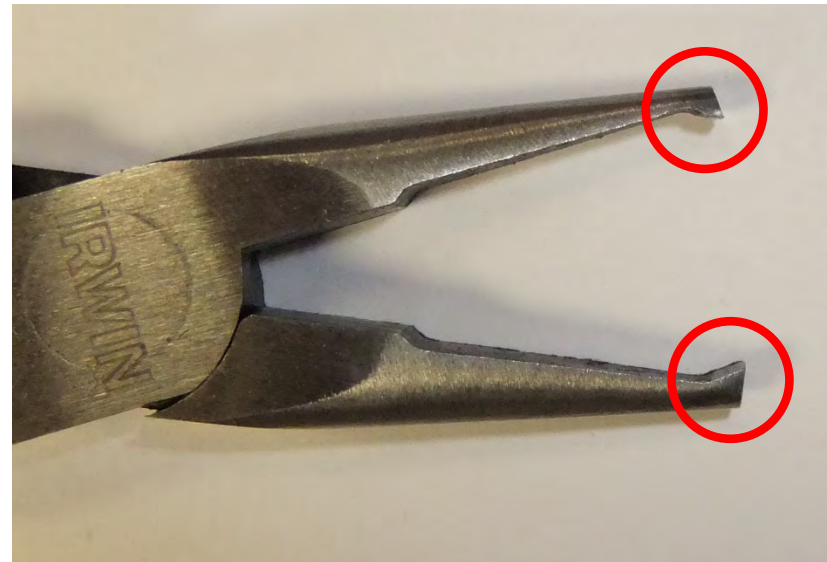
- Do not use or leave the battery at very high temperature (for example, in strong/direct sunlight or in a vehicle in extremely hot weather). Otherwise, it can overheat or catch fire or its performance will be degenerate and its service life will be shortened.
- Do not use it in locations prone to static electric discharges, otherwise, the safety devices may be damaged, causing a harmful situation.
- In case the electrolyte gets into the eyes due to the leakage of battery, do not rub the eyes!
- Rinse the eyes with clean running water, and seek medical attention immediately. Otherwise, it may injure eyes or cause a loss of sight.
- If the battery gives off an odor, generates heat, becomes discolored or deformed, or in any way appears abnormal during use, recharging or storage, immediately remove it from the device or battery charger and place it in a contained vessel such as a metal box.
- In case the battery terminals are contaminated, clean the terminals with a dry cloth before use.
- Otherwise power failure or charge failure may occur due to the poor connection between the battery and the electronic circuitry of the instrument.
- Be aware that discarded batteries may cause fire - tape the battery terminals to insulate them before disposal.

Taking Care of your Batteries

- Be careful plugging the batteries into the power board and un-plugging from the power board.
- Repeatedly pulling/pushing on the wires can cause them to be pulled from the connector (rendering the battery useless) and/or cause a dangerous short.
 - This can also wear out the male power connector on the power board
- We have a few tools and techniques to help keep your batteries in good shape...

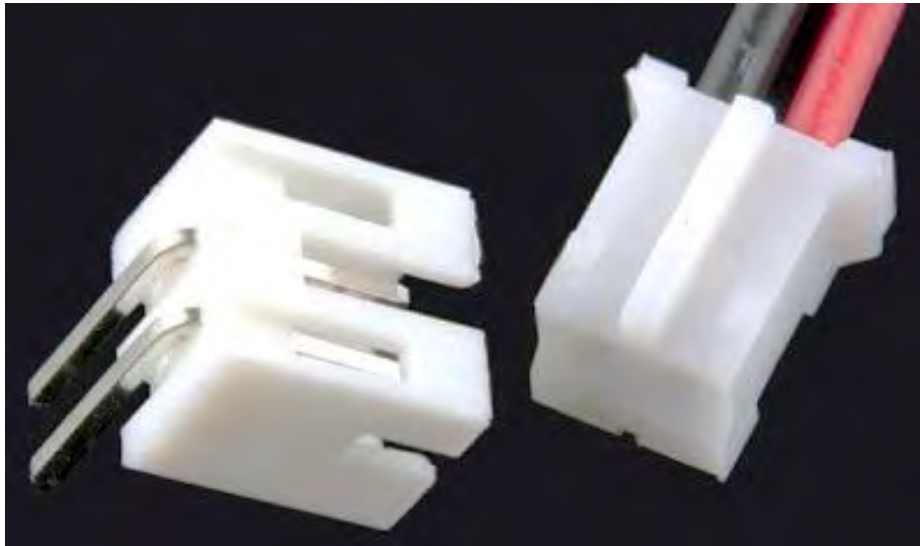
Transverse End Cutter Pliers = Great “Connector Pullers”

- The tool we will use as a “connector puller” is a transverse end cutter pliers, should you need to get a replacement
 - These work well because you are able to grab the connector firmly and pull the connector out, lessening the risk of slipping off the connector and damaging the wires.
 - These are not cheap! Try and take care of the one in your kit.
 - Should you buy a new connector puller, take a metal file and file down the sharp “teeth” of the pliers so they don’t cut into the connector.



Connector “Gender”

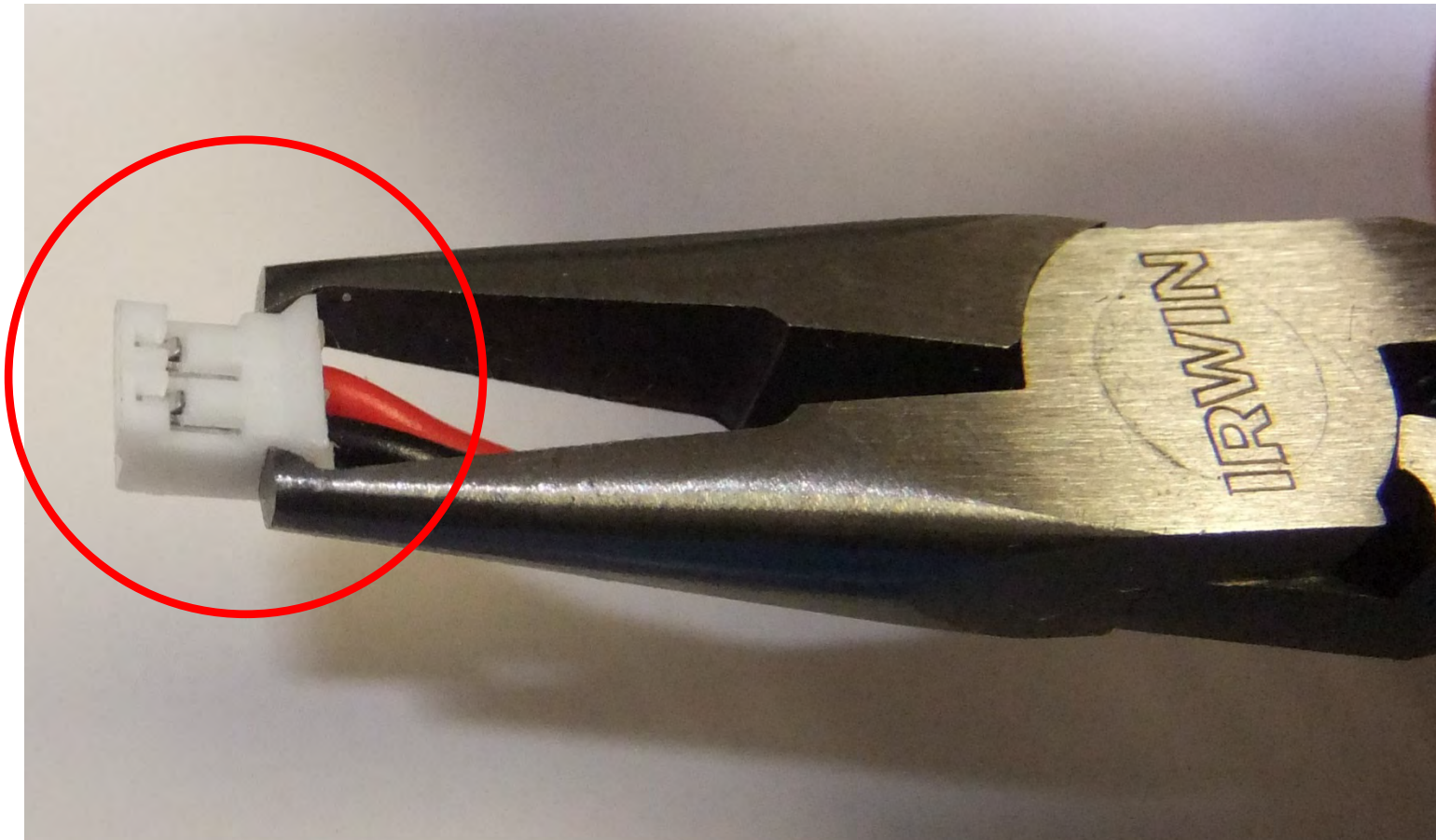
Gender - The gender of a connector refers to whether it plugs in or is plugged into and is typically male or female, respectively (kids, ask your parents for a more thorough explanation). Unfortunately, there are cases where a connector may be referred to as “male” when it would appear to be female



Male (left) and female 2.0mm PH series JST connectors. In this case, gender is determined by the individual conductor.

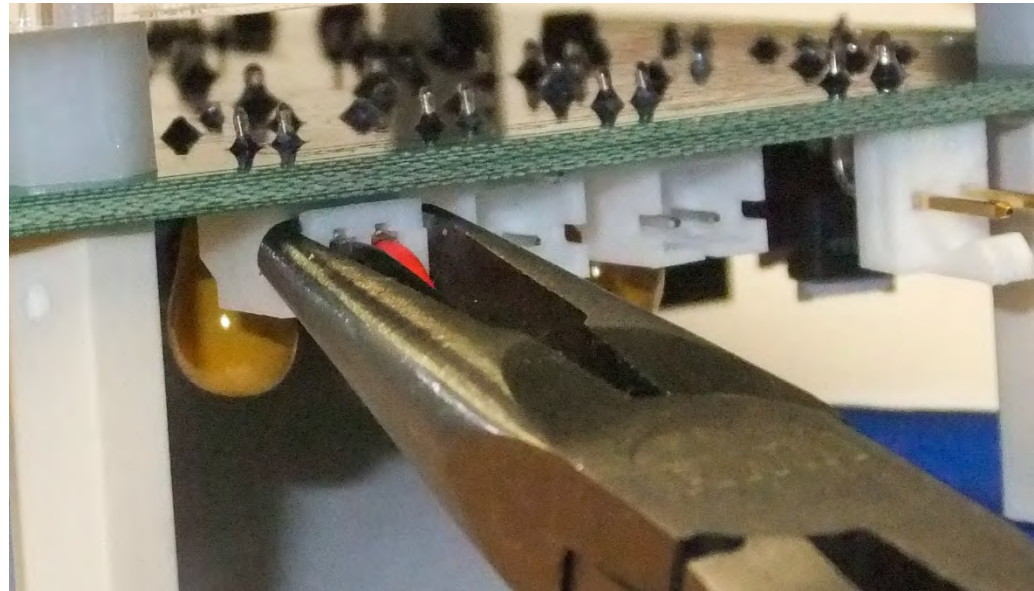
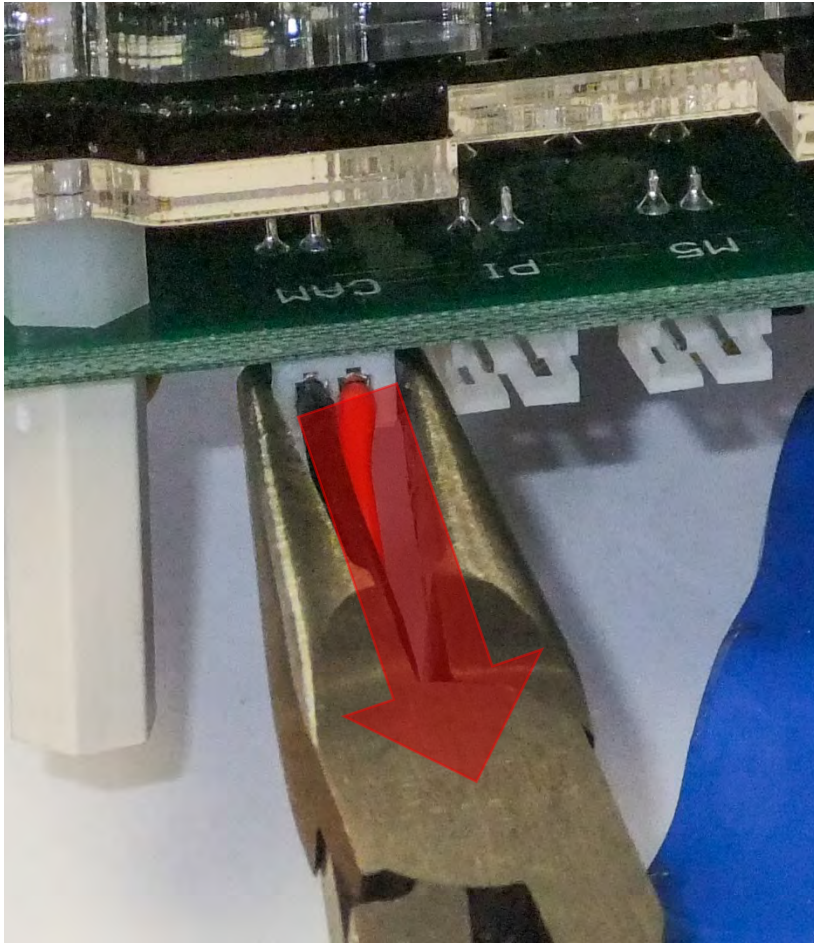
Using the Connector Pullers

You can use these to both insert the battery connectors or to remove the battery connectors from the power boards. Grab the connector right behind the connector where it flares out. Don't squeeze the connector too tight lest you cut into the connector.



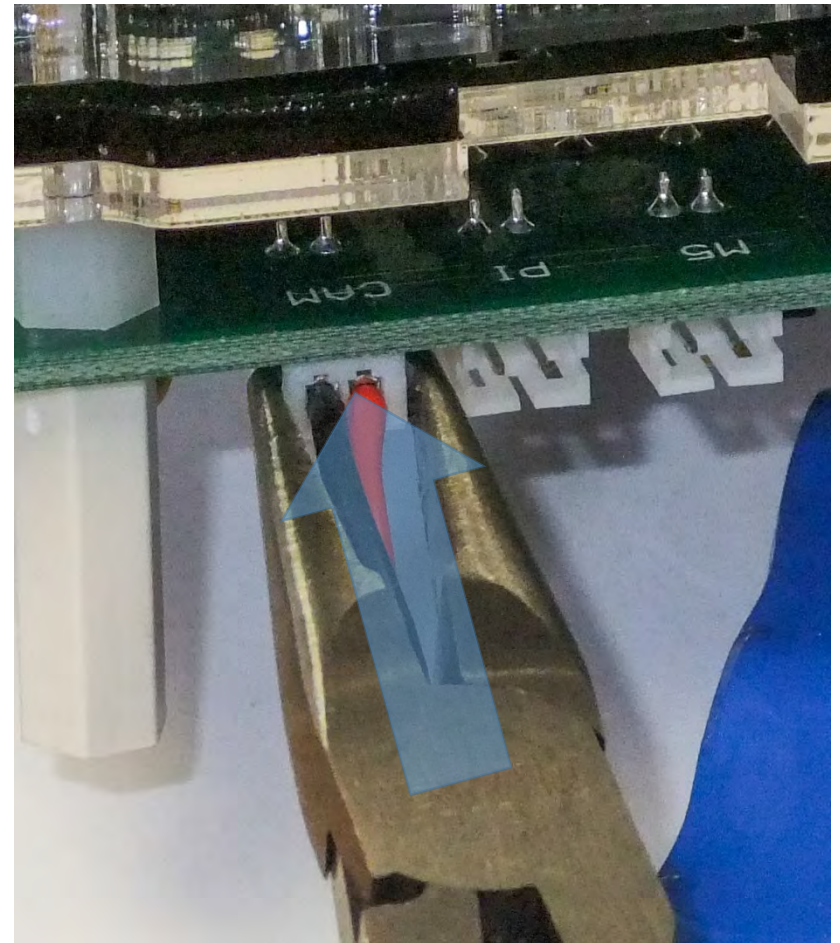
Using the Connector Pullers

To remove the battery connector, grab the connector right behind where the end “flares” out and gently pull straight out. Make sure you grip just the female connector which is connected to the battery wires and not the male end connected to the power board.



Using the Connector Pullers

To insert the battery connector, grab the connector right behind where the end “flares” out and gently push it in. Don’t push too hard as you can damage the male connector on the power board.



WARNING!!!!!!

NEVER CONNECT A MODEM TO POWER UNLESS IT HAS THE ANTENNA(S) CONNECTED TO IT!

CONNECTING A MODEM TO POWER WITHOUT AN ANTENNA CONNECTED WILL DESTROY THE MODEM RENDERING IT USELESS!

NONE OF THESE MODEMS ARE CHEAP AND SOME ARE VERY EXPENSIVE (~\$700)!

Building the Still Image Payload: Connecting Batteries and RFD antennas

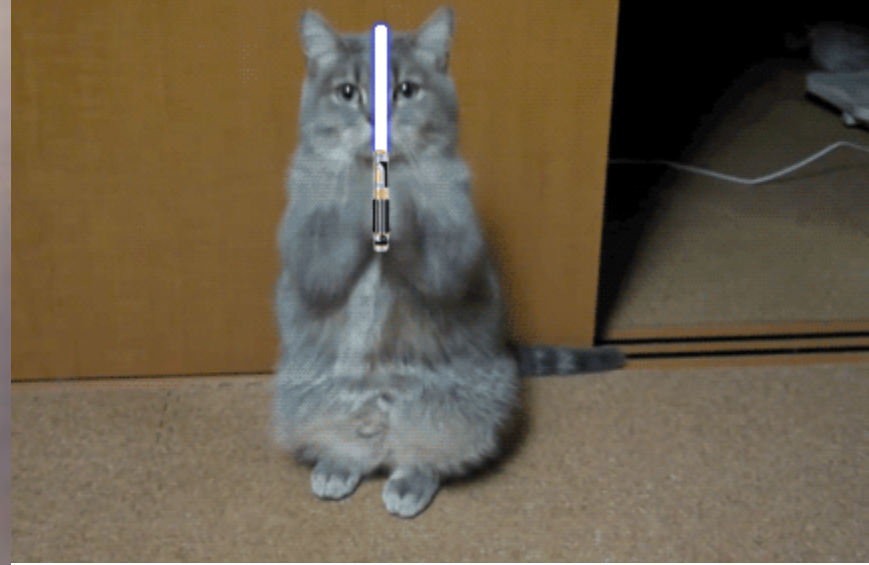
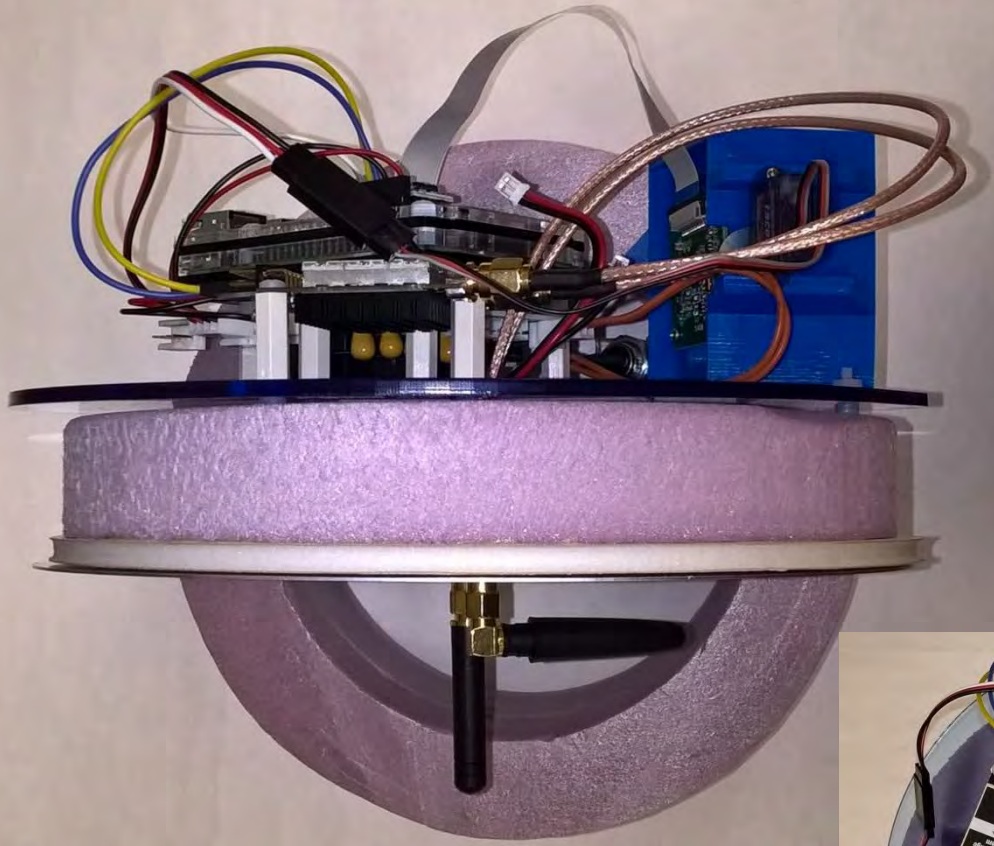
Plug the batteries into the two pin connectors labeled Pi and M5 on the bottom of the power board. The extra male connector labeled CAM is for an extra battery pack to supply extra power for an additional 5V source (for an additional camera system for example).



BEFORE PLUGGING IN BATTERIES MAKE SURE THE KEY SWITCH IS IN THE OFF POSITION AND PLUGGED INTO THE POWER BOARD!



Building the Still Image Payload: Payload Construction Complete!



(Jedi cat approves)



Using the RFD System

- Please note that some of the filenames or paths may differ slightly from what you have on your ground station laptop.

Yagi
Antenna

Connecting Ground Station to Laptop

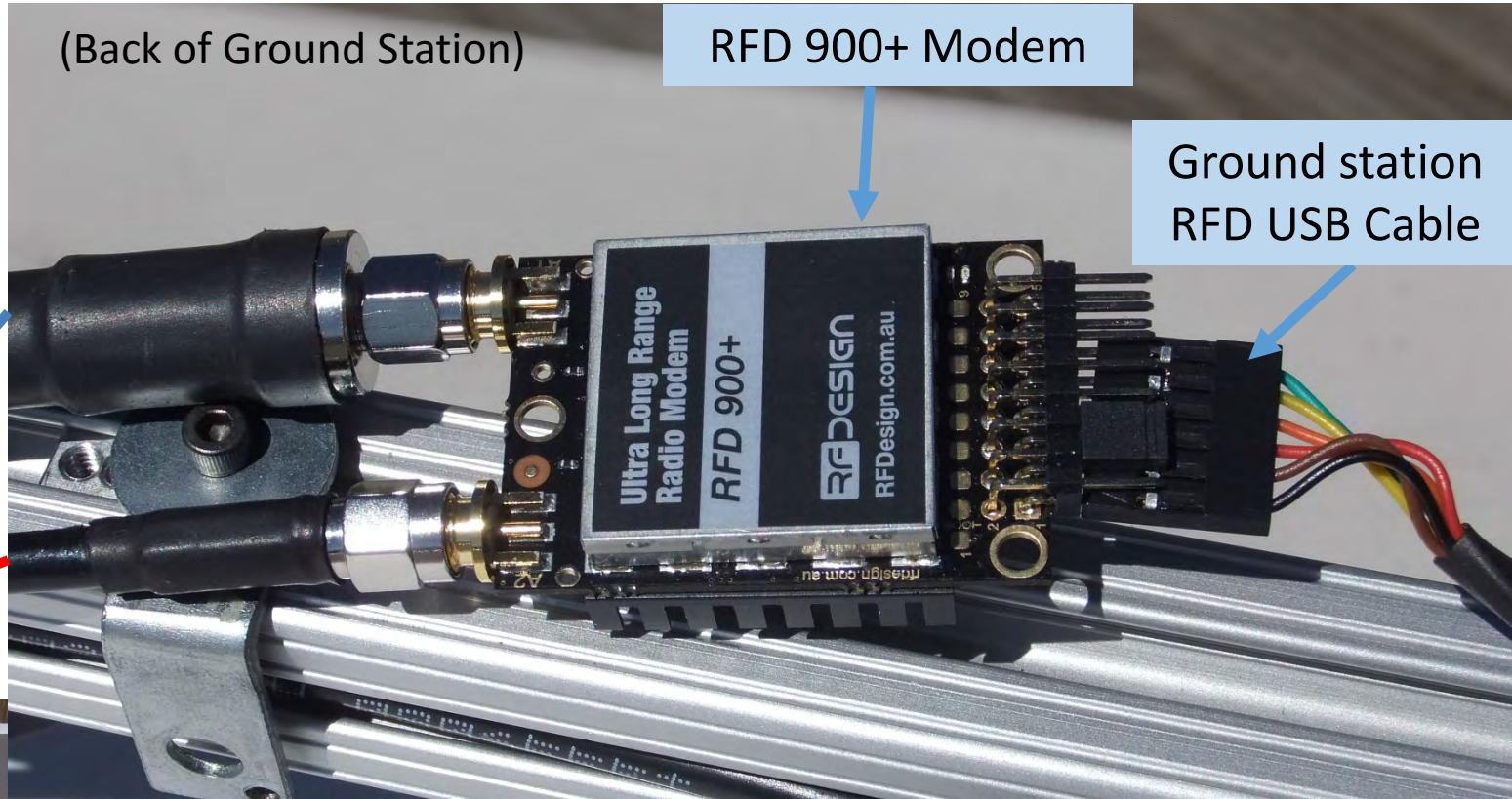
(Back of Ground Station)

RFD 900+ Modem

Ground station
RFD USB Cable

Connects to

Connects to

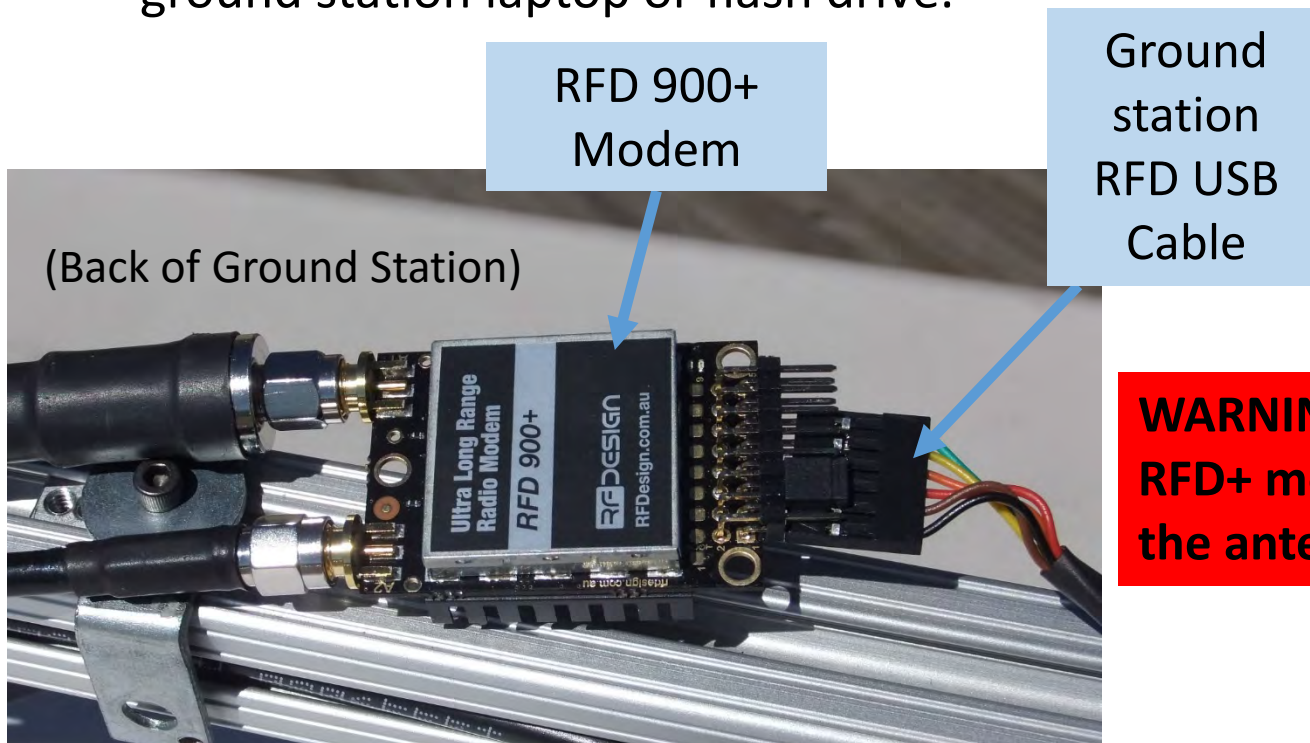


Plug the Ground station RFD USB Cable into laptop (**note which USB port is used, this port will be dedicated to the RFD USB cable so you don't have to repeat these steps**)

Patch Antenna

Programming the Ground Station and Payload RFD Modem

- Plug the USB going from the RFD 900+ modem on the ground station to the ground station laptop.
- Watch the configuring RFD videos in the folder RFD_Video on your ground station laptop or flash drive.



Programming the Ground Station and Payload RFD Modem

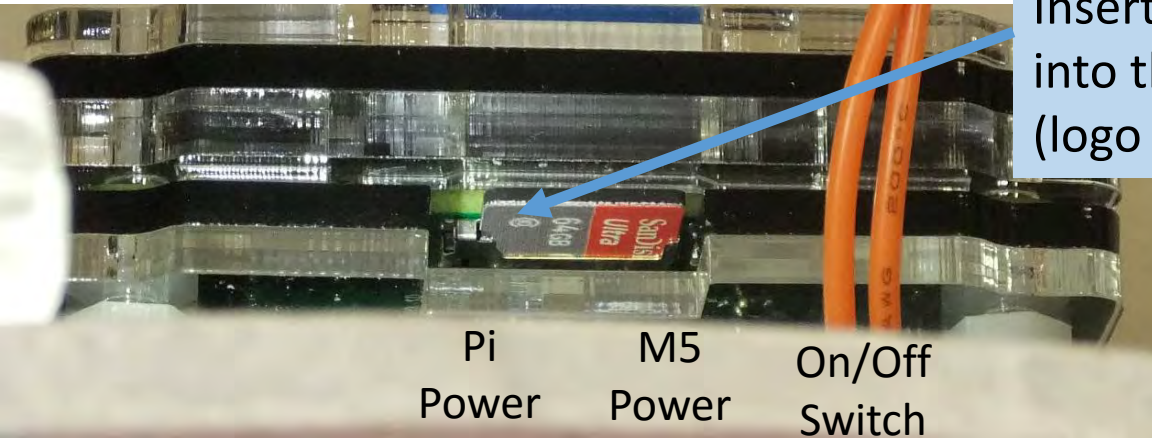
- You can use the same USB plug for programming the RFD 900+ modem on the payload. Simply remove the **RFD/Pi cable** (w/ black, red, blue yellow wires from the black connector) from the payload RFD modem and plug in the **RFD USB cable**
- Watch the RFD configuring videos for instructions

RFD 900+ Modem

WARNING! – Do not plug in the RFD+ modem to power unless the antennas are connected!!!

RFD USB cable

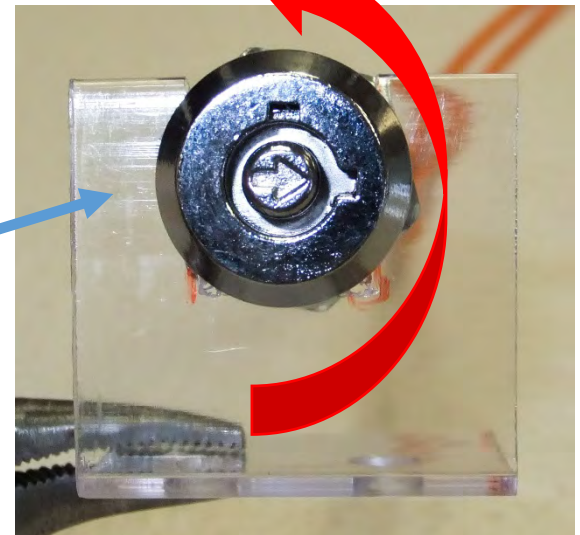
RFD900 Pi System Prep (Payload)



Insert the **RFD Micro SD card** into the Pi here with pins face up (logo face down)

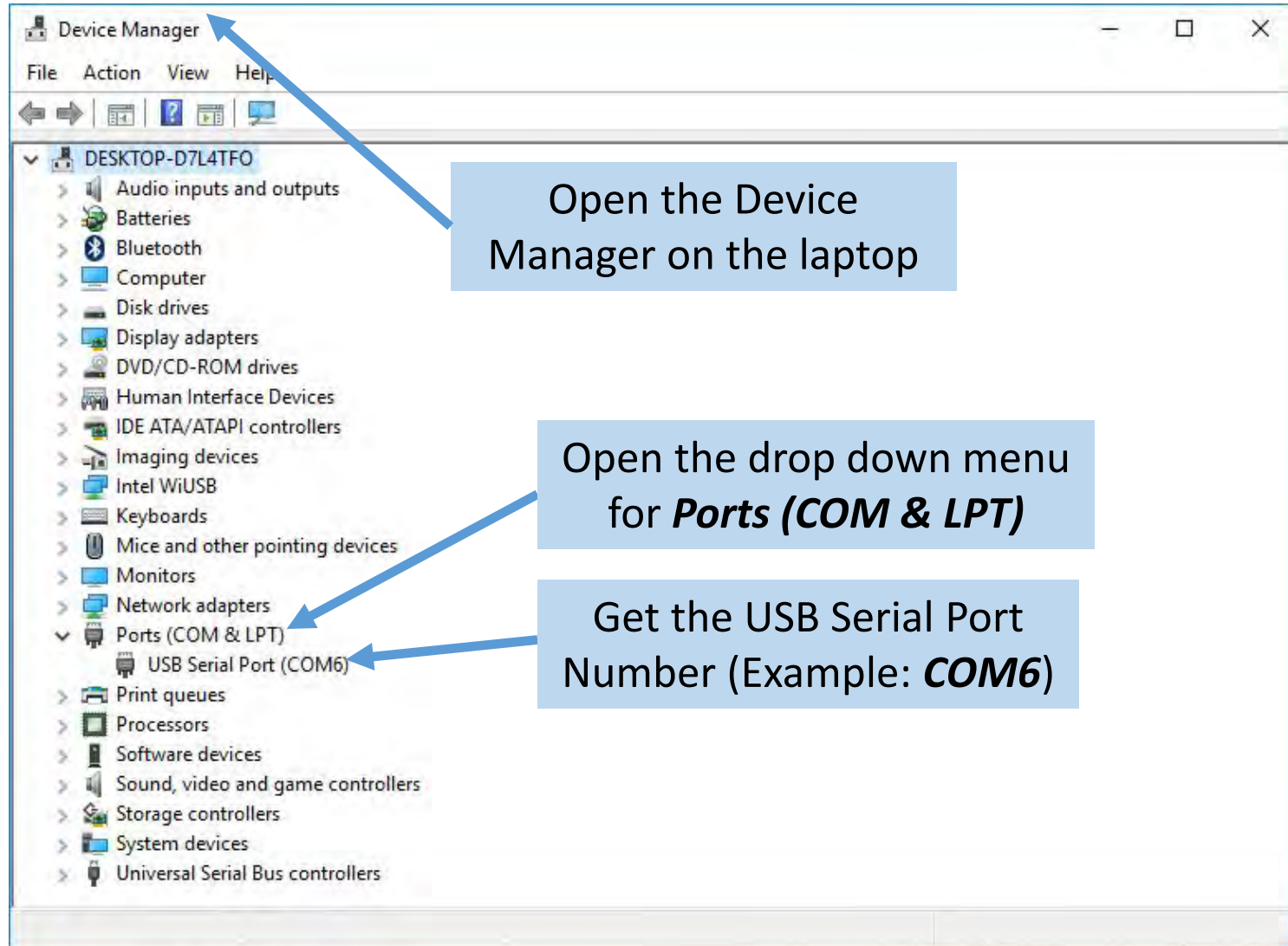
Pi	M5	On/Off
Power	Power	Switch
Cable	Cable	Cable

To turn on the Pi, insert key at the “3-o’clock” position and turn CCW to the “12-o’clock” position. To turn off, insert key into the “12-o’clock” position and turn to the “3-o’clock” position



NOTE Make sure the still image payload is on and running **BEFORE** the RFD ground station is running and looking for the payload

Connecting Ground Station to Laptop: Finding the Com Port



Open the Device Manager on the laptop

Open the drop down menu for **Ports (COM & LPT)**

Get the USB Serial Port Number (Example: **COM6**)

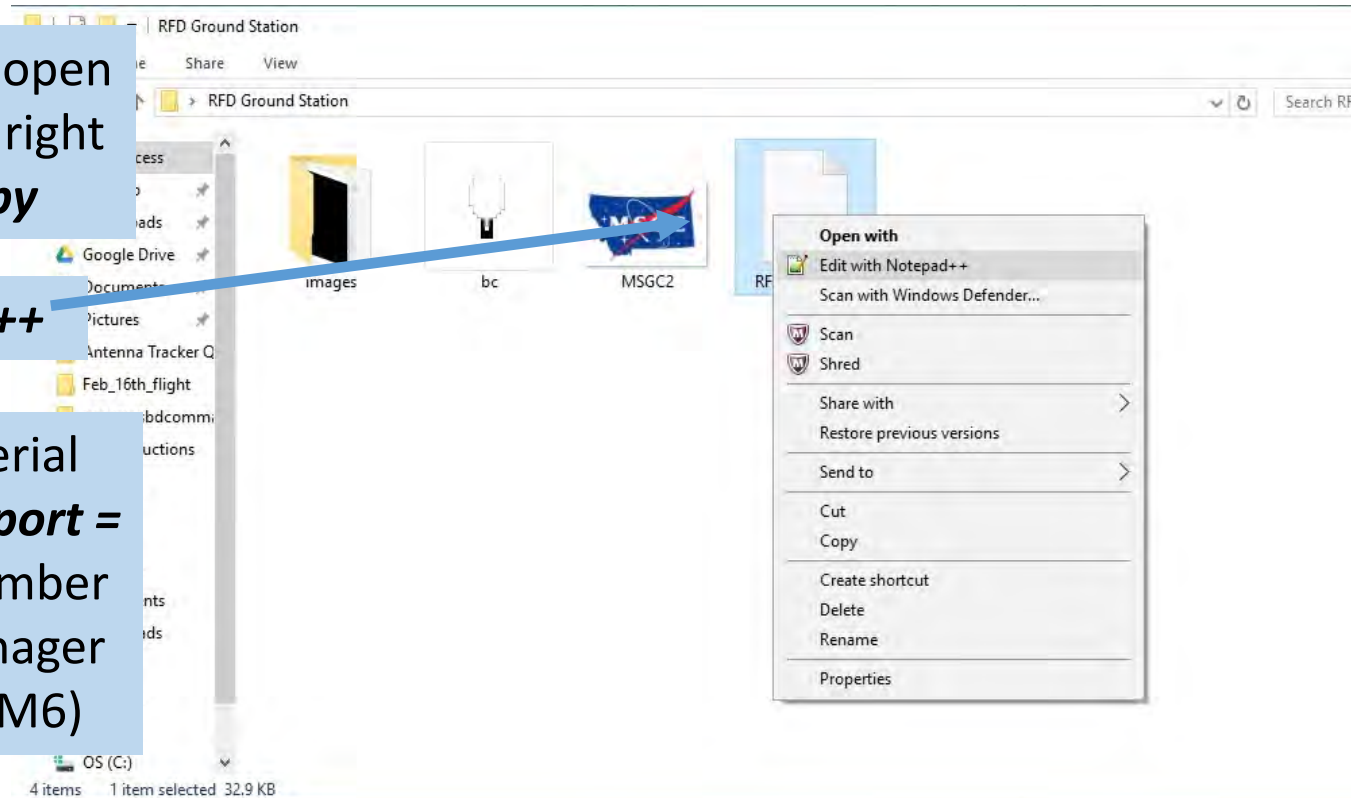
(Type "Device Manager" into Windows search in the start menu for quick access)

Connecting Ground Station to Laptop (Cont.)

From the laptop desktop open **RFD Ground Station** and right click on **RFD900_PC.py**

Click **Edit with Notepad++**

In Notepad++, under Serial Variables at line 39, edit **port = "COM18"** to the port number you found in Device Manager (Example: COM18→COM6)



Save changes and close Notepad++

```
34
35 #-----
36 #Global Variable Initialization and Definitions
37
38 #Serial Variables
39 port = "COM18" #This is a computer dependent setting. Open Device Manager to determine which port the RFD900 Modem is plugged into
40 baud = 38400
41 timeout = 3 #Sets the ser.read() timeout period, or when to continue in the code when no data is received after the timeout period
42
43 #Initializations
44 ser = serial.Serial(port = port, baudrate = baud, timeout = timeout)
45 wordlength = 10000 #Variable to determine spacing of checksum. Ex. wordlength = 1000 will send one thousand bits before calculating and v
46 imagedata_size = 10000
```

Starting the RFD900 Program: Anaconda

Open *Anaconda Prompt* and the following will be displayed: `[Anaconda2] C:\Users\BOREALIS GS>`

NOTE Your computer name will differ!

Type `cd Desktop\RFD Ground Station` and hit [ENTER]

The following will now be displayed:
`[Anaconda2] C:\Users\BOREALIS GS\Desktop\RFD Ground Station>`

The screenshot shows the Anaconda Prompt window with the following text:

```
Anaconda Prompt
Deactivating environment "C:\Users\BOREALIS GS\Anaconda2"...
Activating environment "C:\Users\BOREALIS GS\Anaconda2"...

[Anaconda2] C:\Users\BOREALIS GS>cd Desktop\RFD Ground Station
[Anaconda2] C:\Users\BOREALIS GS\Desktop\RFD Ground Station>dir
Volume in drive C is OS
Volume Serial Number is 9488-D223

Directory of C:\Users\BOREALIS GS\Desktop\RFD Ground Station

03/15/2016  11:44 AM    <DIR>          .
03/15/2016  11:44 AM    <DIR>          ..
05/28/2015  11:38 AM             1,406 bc.ico
03/15/2016  11:44 AM    <DIR>          images
05/28/2015  11:38 AM            30,002 MSGC2.jpg
03/14/2016  02:53 PM            33,789 RFD900_PC.py
             3 File(s)          65,197 bytes
             3 Dir(s)    439,410,761,728 bytes free

[Anaconda2] C:\Users\BOREALIS GS\Desktop\RFD Ground Station>
```

Typing *dir* and hitting [Enter] will display all the contents of the RFD Ground Station folder.

The program we want to run is *RFD900_PC.py*

Starting the RFD Program: Anaconda (Cont.)

```
Anaconda Prompt
Deactivating environment "C:\Users\BOREALIS GS\Anaconda2"...
Activating environment "C:\Users\BOREALIS GS\Anaconda2"...

[Anaconda2] C:\Users\BOREALIS GS>cd Desktop\RFD Ground Station

[Anaconda2] C:\Users\BOREALIS GS\Desktop\RFD Ground Station>dir
Volume in drive C is OS
Volume Serial Number is 9488-D223

Directory of C:\Users\BOREALIS GS\Desktop\RFD Ground Station

03/15/2016  11:44 AM    <DIR>          .
03/15/2016  11:44 AM    <DIR>          ..
05/28/2015  11:38 AM             1,406 bc.ico
03/15/2016  11:44 AM    <DIR>          images
05/28/2015  11:38 AM            30,002 MSGC2.jpg
03/14/2016  02:53 PM            33,789 RFD900_PC.py
           3 File(s)          65,197 bytes
           3 Dir(s)    439,410,761,728 bytes free

[Anaconda2] C:\Users\BOREALIS GS\Desktop\RFD Ground Station>python RFD900_PC.py
```

To open the RFD GUI window, type the following in the command prompt: ***python RFD900_PC.py*** and hit [ENTER].

Note You must put ***python*** before the file name as this tells Anaconda to use python to run the file ***RFD900_PC.py***

RFD GUI Screen

Command Module

Image Save Name : Default = image_XXXX_b.png
Most Recent Photo

Data File Save Name: Default = imagedata.txt
Request 'imagedata.txt'

```
03/15/2016 12:04:40
03/15/2016 12:04:35
03/15/2016 12:04:30
03/15/2016 12:04:25
03/15/2016 12:04:20
03/15/2016 12:04:15
03/15/2016 12:04:10
03/15/2016 12:04:05
03/15/2016 12:04:00
03/15/2016 12:03:55
03/15/2016 12:03:50
03/15/2016 12:03:45
Ping Response Time = 0.23 seconds
#####
Local Time = 03/15/2016 12:03:38
#####
Raspb Time = 03/15/2016 12:03:31
#####
```

Connection Test

03/15/2016 12:04:30
03/15/2016 12:04:35
03/15/2016 12:04:40
03/15/2016 12:04:45

Settings Panel:

- No Recent Update
- 650 Current Width = 650
- 450 Current Height = 450
- 0 Current Sharpness = 0
- 50 Current Brightness = 50
- 0 Current Contrast = 0
- 0 Current Saturation = 0
- 400 Current ISO = 400

Default Settings
Send New Settings | Get Current Settings

It is recommended that the **Anaconda Prompt** window stay open and visible so program feedback can be seen

A second window for **Image Data and Selection** is minimized here.

RFD GUI Screen (Cont.)

Request the most recent photo that was taken and stored by the Pi camera

Montana Space Grant Consortium Borealis Program

RFD900 Interface V7.0

Command Module

Image Save Name : Default = image_XXXXCb.png

Most Recent Photo

Data File Save Name : Default = imagedata.txt

Request 'imagedata.txt'

03/15/2016 12:05:20
03/15/2016 12:05:15
03/15/2016 12:05:10
03/15/2016 12:05:05
03/15/2016 12:05:00
03/15/2016 12:04:55
03/15/2016 12:04:50
03/15/2016 12:04:45
03/15/2016 12:04:40
03/15/2016 12:04:35
03/15/2016 12:04:30
03/15/2016 12:04:25
03/15/2016 12:04:20
03/15/2016 12:04:15
03/15/2016 12:04:10
03/15/2016 12:04:05
03/15/2016 12:04:00
03/15/2016 12:03:55
03/15/2016 12:03:50
03/15/2016 12:03:45

Connection Test

No Recent Update

650 Current Width = 650

450 Current Height = 450

0 Current Sharpness = 0

50 Current Brightness = 50

0 Current Contrast = 0

0 Current Saturation = 0

400 Current ISO = 400

Default Settings

Send New Settings | Get Current Settings

Check your connection between the ground station and payload: ground station will attempt to contact the payload and receive confirmation

Most recent requested image will be displayed here (default image is displayed before an image is requested, you can change the default image if you wish)

RFD GUI Screen (Cont.)

Request the list of all images taken by the Pi camera since power up

Pi camera setting adjustment sliders

Montana Space Grant Consortium Borealis Program

RFD900 Interface V7.0

Command Module

Image Save Name : Default = image_XXXX_b.png

Most Recent Photo

Data File Save Name: Default = imagedata.txt

Request 'imagedata.txt'

03/15/2016 12:05:20
03/15/2016 12:05:15
03/15/2016 12:05:10
03/15/2016 12:05:05
03/15/2016 12:05:00
03/15/2016 12:04:55
03/15/2016 12:04:50
03/15/2016 12:04:45
03/15/2016 12:04:40
03/15/2016 12:04:35
03/15/2016 12:04:30
03/15/2016 12:04:25
03/15/2016 12:04:20
03/15/2016 12:04:15
03/15/2016 12:04:10
03/15/2016 12:04:05
03/15/2016 12:04:00
03/15/2016 12:03:55
03/15/2016 12:03:50
03/15/2016 12:03:45

Connection Test

Restore sliders to default settings

No Recent Update

650 Current Width = 650

450 Current Height = 450

0 Current Sharpness = 0

50 Current Brightness = 50

0 Current Contrast = 0

0 Current Saturation = 0

400 Current ISO = 400

Default Settings

Send New Settings | Get Current Settings

Check the connection between the ground station and the payload: ground station will attempt to contact the payload and receive confirmation

Send camera setting changes to the payload

Download current Pi camera settings (this will adjust sliders)

How the Pi Camera System Works

- The Pi Camera System can perform one task at a time through the GUI. If you ask for multiple tasks to be performed, it will execute one task after the next. The GUI window may display “program not responding” until the tasks are completed.
- Pi Camera is programmed to take and store on the memory card in the pi a new image every 60 seconds (this can be changed).
- You can request to download the most recent image on the Pi or request a list of all the saved images and pick the one you want to download.

Request Most Recent Photo

Click Most Recent Photo

The screenshot shows the 'RFD900 Interface V7.0' application window. The title bar reads 'Montana Space Grant Consortium Borealis Program (Not Responding)'. The main window is divided into several sections:

- Command Module:** Contains fields for 'Image Save Name' (Default: image_XXXX.bmp) and 'Data File Save Name' (Default: imagedata.txt). A button labeled 'Request 'imagedata.txt'' is visible.
- Log:** A list of timestamps from 03/15/2016 12:31:39 down to 12:30:24. Below the list, it shows 'Ping Response Time = 0.23 seconds' and 'Local Time = 03/15/2016 12:30:18'.
- Image:** A large central area displaying a photograph of a satellite dish. A blue box with white text is overlaid on this image, stating: 'The program is running, but "Not Responding" will be displayed until image is downloaded and displayed'. A blue arrow points from the 'Most Recent Photo' button to this image.
- Settings:** A panel on the right titled 'No Recent Update' with sliders for 'Current Width = 650', 'Current Height = 450', 'Current Sharpness = 0', 'Current Brightness = 50', 'Current Contrast = 0', 'Current Saturation = 0', and 'Current ISO = 400'. Buttons for 'Default Settings', 'Send New Settings', and 'Get Current Settings' are at the bottom.

The program is running, but "Not Responding" will be displayed until image is downloaded and displayed

You can see download progress (in 10,000 bit chunks) in the **Anaconda Prompt** window. The image will take a minute or two to download.

```
Current Recieve Position: 90000
Current Recieve Position: 100000
Current Recieve Position: 110000
Current Recieve Position: 120000
Current Recieve Position: 130000
Current Recieve Position: 140000
```

Request Most Recent Photo: Download Complete

The screenshot displays the 'RFD900 Interface V7.0' software window. On the left, the 'Command Module' contains fields for 'Image Save Name' (Default: image_XXXX_b.png) and 'Data File Save Name' (Default: imagedata.txt), along with buttons for 'Most Recent Photo' and 'Request 'imagedata.txt''. Below these is a list of timestamps from 03/15/2016 12:34:24 down to 12:33:28, and a 'Connection Test' button. The central area shows a live video feed from 'Camera A' of an outdoor parking lot with a building and utility poles. On the right, a settings panel titled 'No Recent Update' includes sliders for 'Current Width = 650', 'Current Height = 450', 'Current Sharpness = 0', 'Current Brightness = 50', 'Current Contrast = 0', 'Current Saturation = 0', and 'Current ISO = 400'. Buttons for 'Default Settings', 'Send New Settings', and 'Get Current Settings' are also present. A blue callout box at the bottom points to the camera feed with the text: 'Most recent image received is displayed here and is saved in the RFD Ground Station folder'. The Windows taskbar at the bottom shows the time as 12:34 PM on 3/15/2016.

Request Most Recent Photo (Cont.)

The screenshot displays the 'Command Module' interface for the RFD900 camera system. The window title is 'Montana Space Grant Consortium Borealis Program' and 'RFD900 Interface V7.0'. The interface is divided into several sections:

- Command Module:** Contains input fields for 'Image Save Name' (set to 'test'), 'Data File Save Name' (set to 'imagedata.txt'), and a 'Request' button. A blue callout box labeled 'Most Recent Photo' points to the 'test' input field.
- Log:** A scrollable list of timestamps and system messages. The most recent entry is '03/15/2016 12:42:02', which corresponds to the 'Image will be saved as: test.png' message.
- Camera Feed:** A live video stream from 'Camera A' showing an outdoor scene with a building and parked vehicles. A blue callout box over the feed states: 'The most recent image can be requested and saved with its own unique filename if you so choose'. An 'OK' dialog box is overlaid on the camera feed.
- Settings Panel:** A control panel on the right with sliders for various parameters: Current Width (650), Current Height (450), Current Sharpness (0), Current Brightness (50), Current Contrast (0), Current Saturation (0), and Current ISO (400). It includes 'Default Settings', 'Send New Settings', and 'Get Current Settings' buttons.

The Windows taskbar at the bottom shows the system clock as 12:42 PM on 3/15/2016.

Request Image Data and Selection List Update

The screenshot displays the RF1500 Interface V7.0 software. On the left, the Command Module includes fields for 'Image Save Name' (Default: image_XXXX_b.png) and 'Data File Save Name' (Default: imagedata.txt). A 'Request 'imagedata.txt'' button is highlighted with a blue box and an arrow. The main window shows a camera view labeled 'Camera A' displaying 'image0046_b.jpg'. On the right, there are sliders for 'Current Width = 650', 'Current Height = 450', 'Current Sharpness = 0', 'Current Brightness = 50', 'Current Contrast = 0', 'Current Saturation = 0', and 'Current ISO = 400'. A 'Settings' button is visible below these sliders. A red-bordered window titled 'Image Data and Selection' is open in the center, displaying a list of image files with their timestamps and settings. The file 'image0047_b.jpg @ time(03/15/2016 12:33:21) settings(w=650,h=450,sh=0,b=50,c=0,sa=0,i=400)' is highlighted in blue. A 'Request Selected Image' button is at the bottom of this window. A light blue text box is overlaid on the left side of the screenshot.

Click Request 'imagedata.txt' to bring up the **Image Data and Selection** window which shows all photos the Pi camera has taken and stored on the onboard memory card since power up.

```
image0048_b.jpg @ t
image0048_a.png @ time(03/15/2016 12:34:30) settings(w=2592,h=1944,sh=0,b=50,c=0,sa=0,i=400)
image0047_b.jpg @ time(03/15/2016 12:33:21) settings(w=650,h=450,sh=0,b=50,c=0,sa=0,i=400)
image0047_a.png @ time(03/15/2016 12:33:20) settings(w=2592,h=1944,sh=0,b=50,c=0,sa=0,i=400)
image0046_b.jpg @ time(03/15/2016 12:31:23) settings(w=650,h=450,sh=0,b=50,c=0,sa=0,i=400)
image0046_a.png @ time(03/15/2016 12:31:22) settings(w=2592,h=1944,sh=0,b=50,c=0,sa=0,i=400)
image0045_b.jpg @ time(03/15/2016 12:30:10) settings(w=650,h=450,sh=0,b=50,c=0,sa=0,i=400)
image0045_a.png @ time(03/15/2016 12:30:09) settings(w=2592,h=1944,sh=0,b=50,c=0,sa=0,i=400)
image0044_b.jpg @ time(03/15/2016 12:28:59) settings(w=650,h=450,sh=0,b=50,c=0,sa=0,i=400)
image0044_a.png @ time(03/15/2016 12:28:58) settings(w=2592,h=1944,sh=0,b=50,c=0,sa=0,i=400)
image0043_b.jpg @ time(03/15/2016 12:27:45) settings(w=650,h=450,sh=0,b=50,c=0,sa=0,i=400)
image0043_a.png @ time(03/15/2016 12:27:44) settings(w=2592,h=1944,sh=0,b=50,c=0,sa=0,i=400)
image0042_b.jpg @ time(03/15/2016 12:26:33) settings(w=650,h=450,sh=0,b=50,c=0,sa=0,i=400)
image0042_a.png @ time(03/15/2016 12:26:33) settings(w=2592,h=1944,sh=0,b=50,c=0,sa=0,i=400)
image0041_b.jpg @ time(03/15/2016 12:25:21) settings(w=650,h=450,sh=0,b=50,c=0,sa=0,i=400)
image0041_a.png @ time(03/15/2016 12:25:20) settings(w=2592,h=1944,sh=0,b=50,c=0,sa=0,i=400)
image0040_b.jpg @ time(03/15/2016 12:24:09) settings(w=650,h=450,sh=0,b=50,c=0,sa=0,i=400)
image0040_a.png @ time(03/15/2016 12:24:08) settings(w=2592,h=1944,sh=0,b=50,c=0,sa=0,i=400)
image0039_b.jpg @ time(03/15/2016 12:22:57) settings(w=650,h=450,sh=0,b=50,c=0,sa=0,i=400)
image0039_a.png @ time(03/15/2016 12:22:57) settings(w=2592,h=1944,sh=0,b=50,c=0,sa=0,i=400)
```


Request Image Data and Selection List Update (Cont.)

Command Module

Image Save Name: Default = image_XXXX_b.png

Most Recent Photo

Data File Save Name: Default = imagedata.txt

Request 'imagedata.txt'

03/15/2016 12:37:33
03/15/2016 12:37:27
03/15/2016 12:37:22
03/15/2016 12:37:17
03/15/2016 12:37:12
03/15/2016 12:37:07
03/15/2016 12:37:02
03/15/2016 12:36:57
03/15/2016 12:36:52
03/15/2016 12:36:47
03/15/2016 12:36:42
03/15/2016 12:36:37
03/15/2016 12:36:32
03/15/2016 12:36:27
03/15/2016 12:36:14
03/15/2016 12:36:09
03/15/2016 12:36:04
03/15/2016 12:35:59
03/15/2016 12:35:54

File Received, Attempting Listbox Update

Connection Test

image0046_b.jpg

Camera A

No Recent Update

650

Current Width = 650

Current Height = 450

Current Sharpness = 0

Current Brightness = 50

Current Contrast = 0

Current Saturation = 0

Current ISO = 400

Image Data and Selection

Click on the image you would like to request

image0048_b.jpg @ t
image0048_a.png @ time(03/15/2016 12:34:30) settings(w=2592,h=1944,sh=0,b=50,c=0,sa=0,i=400)
image0046_b.jpg @ time(03/15/2016 12:33:21) settings(w=650,h=450,sh=0,b=50,c=0,sa=0,i=400)
image0046_a.png @ time(03/15/2016 12:33:20) settings(w=2592,h=1944,sh=0,b=50,c=0,sa=0,i=400)
image0046_b.jpg @ time(03/15/2016 12:31:23) settings(w=650,h=450,sh=0,b=50,c=0,sa=0,i=400)
image0046_a.png @ time(03/15/2016 12:31:22) settings(w=2592,h=1944,sh=0,b=50,c=0,sa=0,i=400)

Selecting an image and clicking **Request Selected Image** will download that image from the Pi to the ground station. Low res images are labeled **b**.

Request Selected Image

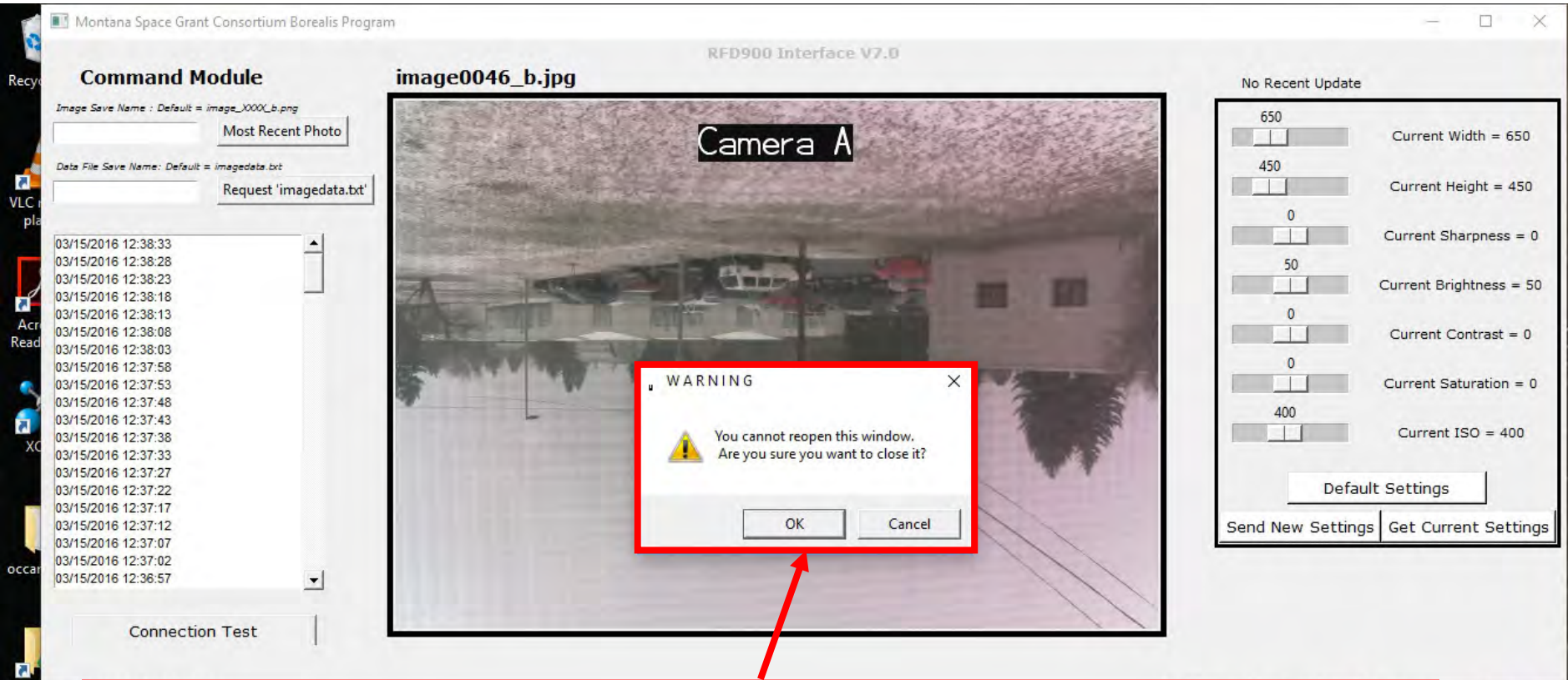
fault Settings

Settings | Get Current Settings

NOTE To avoid excessive download times click on a low res photo (b) when requesting an image!

Image Data and Selection Window (Don't Close it)

The **Image Data and Selection** window opens automatically in separate window when the GUI is launched. Leave it in the background or minimized when unused.



Should the **Image Data and Selection** window be closed, this warning will be displayed. If **OK** is clicked, you can retrieve the **Data and Selection** window by closing the RFD900 program and Anaconda Prompt window and re-open the program via a new Anaconda Prompt window.

Digital Imaging Settings

- **Current width/height:** Change the aspect ratio and resolution of image.
- **Current Sharpness:** Increasing will make the image have “crisper” details. Decreasing will give the image a “soft” or slight fuzzy look. Increasing sharpness too much will make compression artifacts stand out.
- **Current Brightness:** Increase or decrease the overall brightness of the image
- **Current Contrast:** Increasing the contrast of the image will make darks darker and the whites whiter to make the image “pop” a bit more. This will also increase the apparent saturation (color intensity) of the image.
- **Current Saturation:** Increases the intensity of colors, making them stand out.
- **Current ISO:** Increasing the iso will allow for a brighter image without increasing exposure times, while compromising image quality. This is helpful if the payload is swinging violently since shorter exposures may keep images from blurring.

Changing Pi Camera Settings

Pi Camera settings can be adjusted from the Ground station and then uploaded to the Pi on the payload.

The screenshot displays the RFD900 Interface V7.0 software. On the left, the 'Command Module' section includes fields for 'Image Save Name' (Default: image_XXXXCb.png) and 'Data File Save Name' (Default: imagedata.txt), along with buttons for 'Most Recent Photo' and 'Request 'imagedata.txt''. Below this is a list of timestamps from 03/15/2016 12:05:20 to 12:03:45 and a 'Connection Test' button. The central area shows a live video feed of a blue logo with the letters 'MSGC' and a red swoosh, overlaid on a white background with stars. On the right, a settings panel titled 'No Recent Update' features sliders for 'Current Width = 650', 'Current Height = 450', 'Current Sharpness = 0', 'Current Brightness = 50', 'Current Contrast = 0', 'Current Saturation = 0', and 'Current ISO = 400'. At the bottom of the settings panel are buttons for 'Default Settings', 'Send New Settings', and 'Get Current Settings'. A blue arrow points from the 'Send New Settings' button to a text box at the bottom of the slide.

After adjusting the sliders, the new settings can be sent to payload by clicking **Send New Settings**

Changing Pi Camera Settings

Pi Camera settings can be adjusted from the Ground station and then uploaded to the Pi on the payload.

The screenshot displays the RFD900 Interface V7.0 software. On the left, the 'Command Module' section includes fields for 'Image Save Name' (Default = image_XXXXCb.png) and 'Data File Save Name' (Default = imagedata.txt), along with buttons for 'Most Recent Photo' and 'Request 'imagedata.txt''. Below this is a log window showing a list of timestamps from 03/15/2016 12:05:20 to 12:03:45. A 'Connection Test' button is at the bottom left. The central area shows a live video feed of the MSGC logo, which features the letters 'MSGC' in white on a blue background with a red swoosh and stars. On the right, the 'No Recent Update' section contains seven sliders for camera settings: Current Width = 650, Current Height = 450, Current Sharpness = 0, Current Brightness = 50, Current Contrast = 0, Current Saturation = 0, and Current ISO = 400. At the bottom of this section are buttons for 'Default Settings', 'Send New Settings', and 'Get Current Settings'. A blue arrow points from the 'Get Current Settings' button to the text box below.

Should the sliders change and need to be adjusted back to the settings currently used by the Pi camera on the payload, click **Get Current Settings**. This will adjust the sliders to the current Pi camera settings on the payload.

Changing Pi Camera Settings

You can adjust the Pi Camera settings from the Ground station and then upload those settings to the Pi on the payload.

The screenshot displays the RFD9000 Interface V7.0 software. On the left, the 'Command Module' section includes fields for 'Image Save Name' (Default: image_XXXX_b.png) and 'Data File Save Name' (Default: imagedata.txt), along with buttons for 'Most Recent Photo' and 'Request 'imagedata.txt''. Below this is a list of timestamps from 03/15/2016 12:05:20 to 12:03:45 and a 'Connection Test' button. The central area shows a large image of the MSGC logo, which features a blue silhouette of Montana with a red swoosh and the letters 'MSGC' in white. On the right, the 'No Recent Update' section contains seven sliders for camera settings: Width (650), Height (450), Sharpness (0), Brightness (50), Contrast (0), Saturation (0), and ISO (400). Below the sliders are three buttons: 'Default Settings', 'Send New Settings', and 'Get Current Settings'. A green arrow points from the 'Send New Settings' button to the text box below, and a blue arrow points from the 'Get Current Settings' button to the same text box.

To put the sliders back to their default positions, click **Default Settings** and then **Send New Settings** if those settings need to be sent to the camera Pi.

GUI and Payload Shutdown

- To shutdown the payload Pi, use a laptop to connect wirelessly to the Pi (using PuTTY). Login to the Pi (Username: pi Password: raspberry) and in the command prompt type **sudo shutdown -h now** and wait ~10 seconds. Insert the key into the key switch and turn it to the 3-o'clock position to turn power off to the payload.
- You can just turn the key switch to off without shutting down the pi, but there is the risk of corrupting the SD card. Images, etc. can still be recovered (using a Linux based computer). It is recommended, even on recovery, that you have a laptop available to wirelessly turn off the RFD Pi.
- To close the GUI, simply click the **x** in the upper right corner and then close the Anaconda Prompt window.