adafruit learning system

DIY Thermal Light Painting - Heat Map Photography

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Guide Contents

Overview

In this project we'll use a temperature sensor to change the color of a NeoPixel ring to create heat map photography. A cyber-tronic looking sensor measures remote infrared light making it a contact-less temperature sensor.

This 3D Printed project comes in two different styles. This neoblaster makes a practical ray gun and this ergomonical handle resembles a magnifying glass.

> This guide was written for the 'original' Gemma board, but can be done with either the original or Gemma M0. We recommend the Gemma M0 as it is easier to use and is more compatible with modern computers!

Prerequisite Guides

- Gemma M0 guide (https://adafru.it/zxE) or the Classic Introducing GEMMA guide (https://adafru.it/e1V)
- Using Melexis MLX90614 (https://adafru.it/dgI)

Tools

- Wire Stripper (https://adafru.it/527)
- 3D Printer (https://adafru.it/d9z)
- Soldering Iron (https://adafru.it/dgJ)

Parts & Supplies

- 24x NeoPixel Ring (https://adafru.it/dgK)
- Gemma M0 (https://adafru.it/ytb) or classic Gemma (https://adafru.it/iif)
- On / Off Slide switch (https://adafru.it/drN)
- Melexis Contact-less Infrared Sensor (https://adafru.it/dgL)
- 3x AAA Battery Holder (https://adafru.it/dcG)
- 30 AWG Wire (https://adafru.it/dgM)

Like this project?

Check out what we based it off of - Public Labs' Thermal Torch! (https://adafru.it/drm)

3D Printing

https://adafru.it/dgN

https://adafru.it/dgN

Parts are optimized to print on a Makerbot Replicator 2 (https://adafru.it/d9z) and sliced with Makerware. Download the parts from thingiverse (https://adafru.it/dgN) and print them out using the recommended settings below.

Ray Gun

This model is composed of 10 pieces that snap-fit together. Each piece should be printed separately in your favorite colored PLA. The diffuser should be printed in transparent PLA to soften the NeoPixel ring.

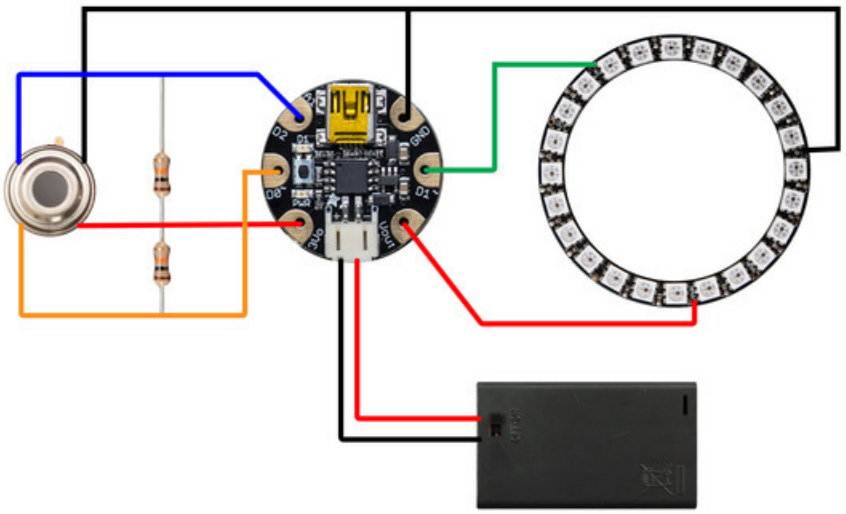
raygun-diffuser.stl raygun-ring.stl raygun-sensor.stl raygun-neck.stl raygun-body.stl raygun-handle-top.stl raygun-handle-btm.stl raygun-handle-lid.stl raygun-cap.stl raygun-cone.stl	PLA @230 %15 infill 2 shells 0.2 layer height 90/150 speeds	12 hours? Like a day! Yes, it's for super crazy 3d printer operators.

Light Handle

Easier to print and assemble, the light handle model is composed of only 4 pieces that snap-fit together.

flir-handle-btm.stl flir-handle-top.stl flir-handle-light.stl flir-handle-diffuser.stl	PLA @230 %15 infill 2 shells 0.2 layer height 90/150 speeds	4-5 hours depending on how soon you switch out the parts!

Circuit Diagram



This diagram uses the original Gemma but you can also use the Gemma M0 with the exact same wiring!

Follow the circuit diagram to and solder the components together using wrapping wire (https://adafru.it/dgM). Carefully measure the lengths of wire to ensure the components will have enough slack to reach the desired location in the 3d Printed model. The ray gun will require significantly more wire.

D1 > **IN** NeoPixel Ring
GND > **GND** NeoPixel Ring
Vout > **PWR** NeoPixel Ring
GND > **Top Right** - MLX90614
3V > **Bottom Right** - MLX90614
D0 > **Bottom Left (Include Resistor)** - MLX90614
D2 > **Top Left (Include Resistor)** - MLX90614
JST > **3X AAA** Battery Holder

Arduino Code

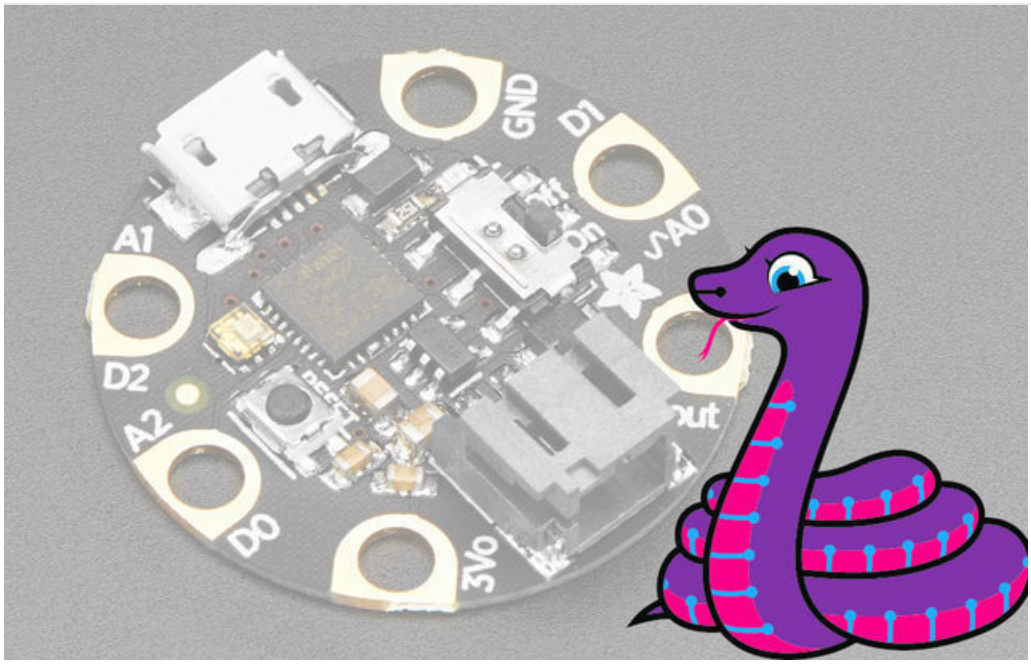
> The Arduino code presented below works well on Gemma v1 and v2. But if you have an M0 board you must use the CircuitPython code on the next page of this guide, no Arduino IDE required!

Make sure to to download the Mini MLX90614 (https://adafru.it/dht), NeoPixel (https://adafru.it/aZU) and TinyWireM Library (https://adafru.it/cEv). Below is a sample sketch that will change the color of the NeoPixel ring depending on temperature values - copy it into your Adafruit Arduino IDE as-is and then mod the temperature values to make it your own. Remember that to program GEMMA you need to download the special Adafruit version of the Arduino IDE from the Introduction to GEMMA guide. (https://adafru.it/dgH)

```
/*************************************************
This is a library for the MLX90614 temperature sensor SPECIFICALLY
FOR USE WITH TINYWIREM ON TRINKET/GEMMA

Requires the latest TinyWireM with repeated-start support
https://github.com/adafruit/TinyWireM

NOT FOR REGULAR ARDUINOS! Use the regular Adafruit_MLX90614 for that

  Designed specifically to work with the MLX90614 sensors in the
  adafruit shop
  ----> https://www.adafruit.com/products/1748
  ----> https://www.adafruit.com/products/1749

  These sensors use I2C to communicate, 2 pins are required to
  interface
  Adafruit invests time and resources providing this open source code,
  please support Adafruit and open-source hardware by purchasing
  products from Adafruit!

  Written by Limor Fried/Ladyada for Adafruit in any redistribution
 *************************************************/

#include <TinyWireM.h>
#include <Adafruit_MiniMLX90614.h>
#include <Adafruit_NeoPixel.h>

// change these to adjust the range of temperatures you want to measure
// (these are in Farenheit)
#define COLDTEMP 60
#define HOTTEMP  80


#define PIN 1
Adafruit_NeoPixel strip = Adafruit_NeoPixel(24, PIN, NEO_GRB + NEO_KHZ800);

Adafruit_MiniMLX90614 mlx = Adafruit_MiniMLX90614();

void setup() {
  mlx.begin();
  strip.begin();
  strip.show(); // Initialize all pixels to 'off'
}

void loop() {
```

```
  uint8_t red, blue;
  float temp = mlx.readObjectTempF();

  if (temp < COLDTEMP) temp = COLDTEMP;
  if (temp > HOTTEMP) temp = HOTTEMP;

  // map temperature to red/blue color
  // hotter temp -> more red
  red = map(temp, COLDTEMP, HOTTEMP, 0, 255);
  // hotter temp -> less blue
  blue = map(temp, COLDTEMP, HOTTEMP, 255, 0);

  colorWipe(strip.Color(red, 0, blue), 0);

  delay(50); // can adjust this for faster/slower updates
}

// Fill the dots one after the other with a color
void colorWipe(uint32_t c, uint8_t wait) {
  for(uint16_t i=0; i<strip.numPixels(); i++) {
      strip.setPixelColor(i, c);
      strip.show();
      delay(wait);
  }
}
```

CircuitPython Code



GEMMA M0 boards can run **CircuitPython** — a different approach to programming compared to Arduino sketches. In fact, **CircuitPython comes factory pre-loaded on GEMMA M0**. If you've overwritten it with an Arduino sketch, or just want to learn the basics of setting up and using CircuitPython, this is explained in the **Adafruit GEMMA M0 guide** (https://adafru.it/z1B).

> These directions are specific to the Gemma M0 board. The original GEMMAs with an 8-bit AVR microcontroller (v1 and v2) doesn't run CircuitPython...for those boards, use the Arduino sketch on the "Arduino code" page of this guide.

Below is CircuitPython code that works similarly (though not the same) as the Arduino sketch shown on a prior page. To use this, plug the GEMMA M0 into USB...it should show up on your computer as a small **flash drive**...then edit the file "**main.py**" with your text editor of choice. Select and copy the code below and paste it into that file, **entirely replacing its contents** (don't mix it in with lingering bits of old code). When you save the file, the code should **start running almost immediately** (if not, see notes at the bottom of this page).

If GEMMA M0 doesn't show up as a drive, follow the GEMMA M0 guide link above to prepare the board for CircuitPython.

This code requires two additional libraries be installed:

1. adafruit_mlx90614
2. adafruit_bus_device
3. neopixel

If you've just reloaded the board with CircuitPython, create the "lib" directory and then download the Adafruit CircuitPython Bundle (https://adafru.it/uap).

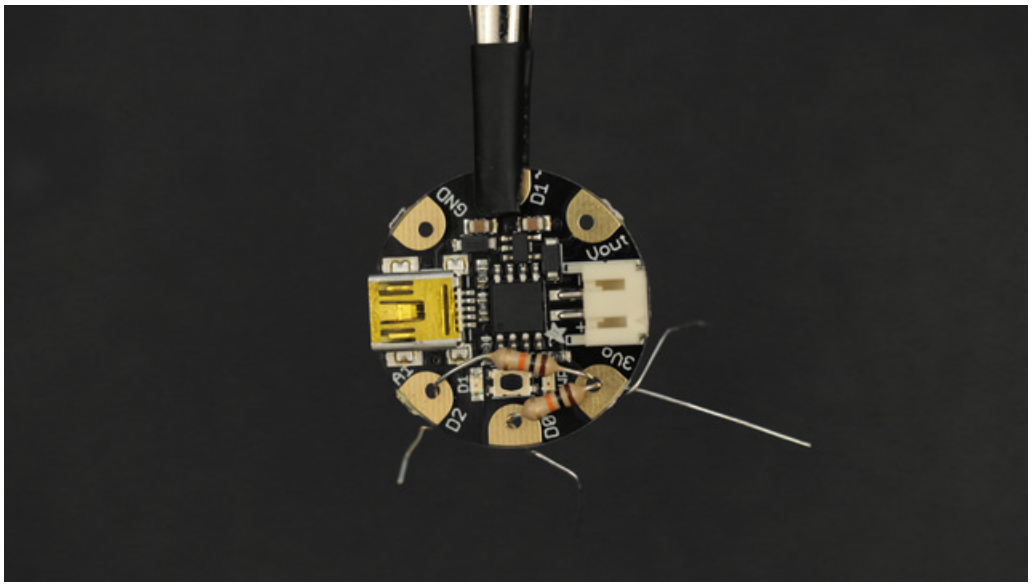
https://adafru.it/uap

```
#  Designed specifically to work with the MLX90614 sensors in the
#  adafruit shop
#  ----> https://www.adafruit.com/product/1747
#  ----> https://www.adafruit.com/product/1748
#
#  These sensors use I2C to communicate, 2 pins are required to
#  interface Adafruit invests time and resources providing this open
#  source code,
#  please support Adafruit and open-source hardware by purchasing
#  products from Adafruit!

import time
import board
import busio as io
import neopixel
import adafruit_mlx90614

# the mlx90614 must be run at 100k [normal speed]
# i2c default mode is is 400k [full speed]
# the mlx90614 will not appear at the default 400k speed
i2c = io.I2C(board.SCL, board.SDA, frequency=100000)
mlx = adafruit_mlx90614.MLX90614(i2c)

# neopixel setup
num_leds = 24           # how many LEDs
led_pin = board.D1      # which pin the neopixel ring is connected to
strip = neopixel.NeoPixel(led_pin, num_leds, brightness=1)

# change these to adjust the range of temperatures you want to measure
# (these are in Farenheit)
cold_temp = 60
hot_temp = 80

def remapRange(value, leftMin, leftMax, rightMin, rightMax):
    # this remaps a value from original (left) range to new (right) range
    # Figure out how 'wide' each range is
    leftSpan = leftMax - leftMin
    rightSpan = rightMax - rightMin

    # Convert the left range into a 0-1 range (int)
    valueScaled = int(value - leftMin) / int(leftSpan)

    # Convert the 0-1 range into a value in the right range.
    return int(rightMin + (valueScaled * rightSpan))

# Fill the dots one after the other with a color
def colorWipe(color):
    for j in range(len(strip)):
        strip[j] = (color)

while True:
    # get object temperature in celsius
    temp = mlx.object_temperature

    # convert object temperature to fahrenheit
    temp = (temp * 9/5) + 32
```

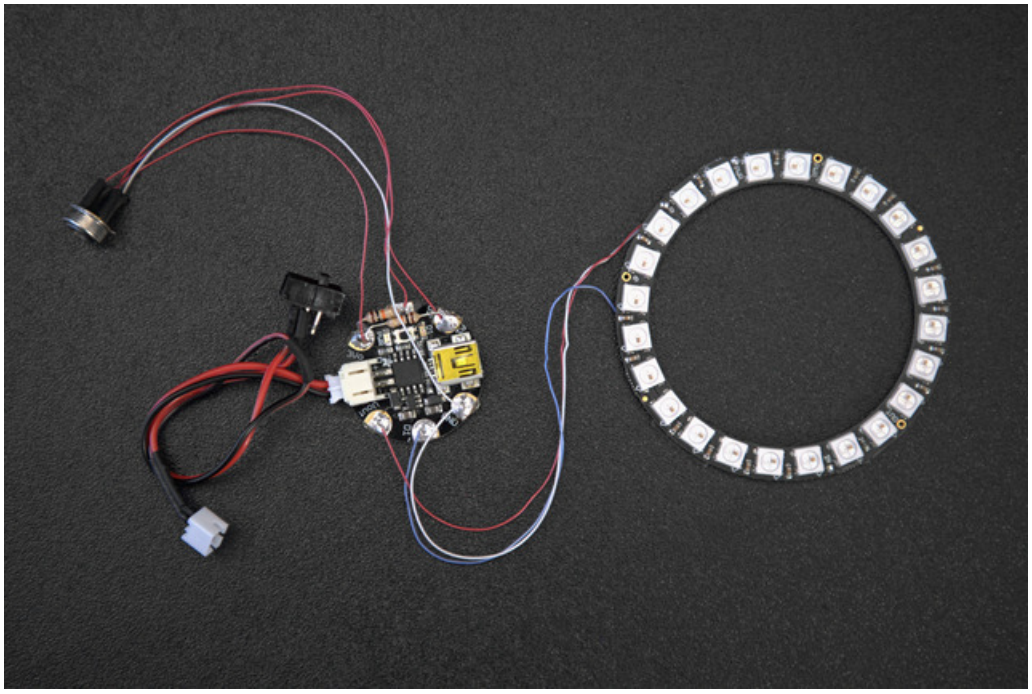
```
    if temp < cold_temp:
        temp = cold_temp

    if temp > hot_temp:
        temp = hot_temp

    # map temperature to red/blue color
    # hotter temp -> more red
    red = remapRange(temp, cold_temp, hot_temp, 0, 255)
    # hotter temp -> less blue
    blue = remapRange(temp, cold_temp, hot_temp, 255, 0)

    colorWipe((red, 0, blue))

    # can adjust this for faster/slower updates
    time.sleep(.05)
```

Assembly

Slide Switch Adapter
This tiny slide switch soldered to a JST extension cable is great way to extend your battery power button. Make sure to use shrink tubing to secure the soldered connections



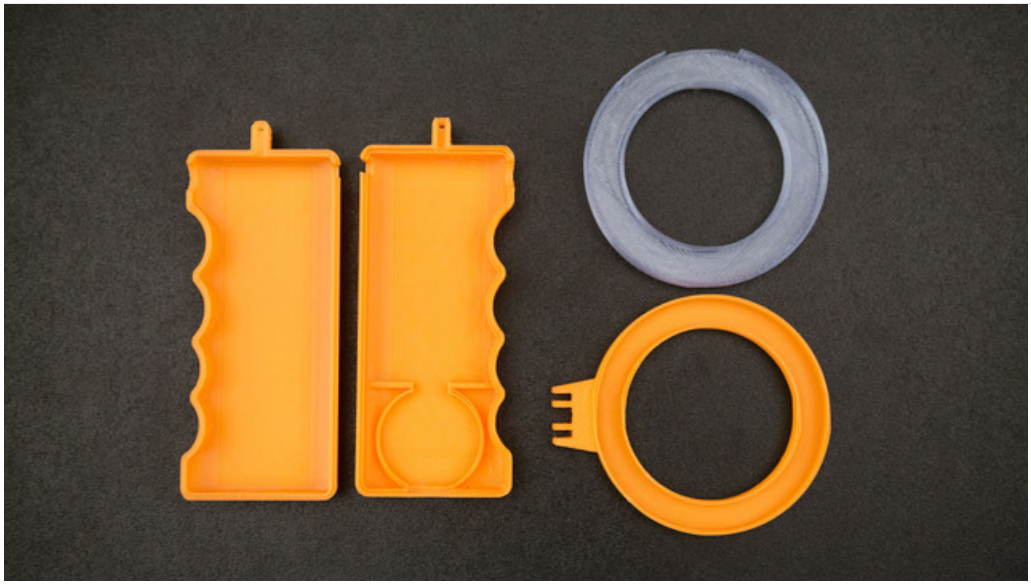
Resistors
The resistors are included with the **MLX90614**. These two resistors can be solder directly on to the **GEMMA**. Both of them will share the **3V pin** of the **GEMMA**.



The Circuit

And heres what the bare circuit looks like. A bit different then the circuit diagram, right? You will need to ensure the **MLX90614** temperature sensor is orientated the correct way in order to solder the connections properly. You can trim the terminals of the sensor. Be sure to use shrink tubing to secure the connections on the sensors.

The Light Handle

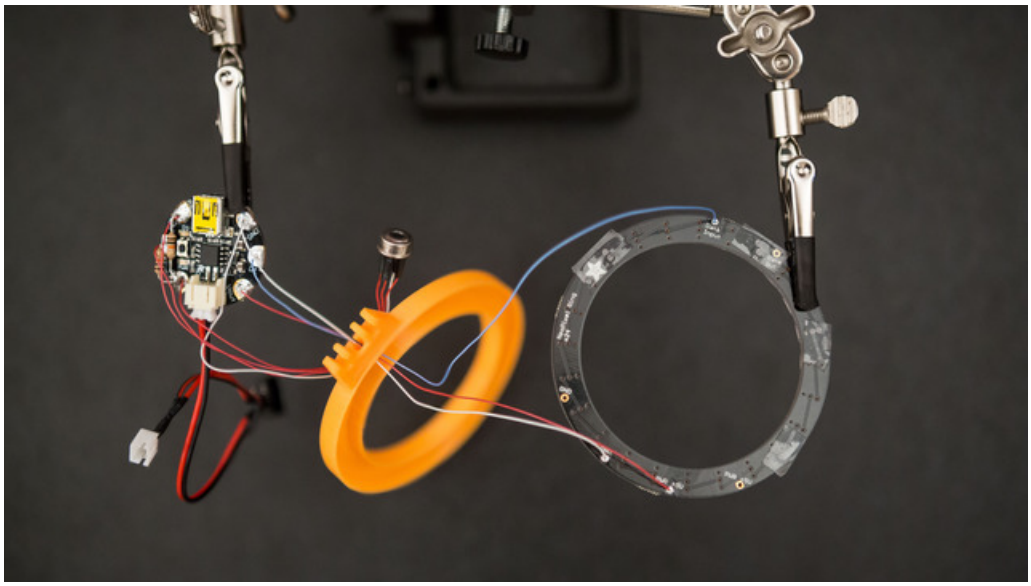


3D Printed Parts
The GEMMA is housed in the **flir-handle-btm.stl** with the **USB port** facing the **bottom**. This allows you to easily reprogram the GEMMA without having to disassemble the handle.

The **3X AAA Battery** holder fits in the large space just above the **GEMMA**. You may need to secure it into place with double sided foam tape or any other plastic-friendly adhesive.

The **slide switch adapter** is held in place between the two handle pieces. The opening is located in the upper back of the handle parts.

The **MLX90614** temperature sensor is housed in the upper front of the handle and also held in place by the two handle parts.



The **24x NeoPixel Ring** is placed inside the **flir-handle-light.stl** with the wires feeding through the hole. The three wires are strung through the opening of the hinge in the **flir-handle-btm.stl** and **flir-handle-top.stl**. A third helping

hand (https://adafru.it/dgP) will help keep the components stationary while you solder.

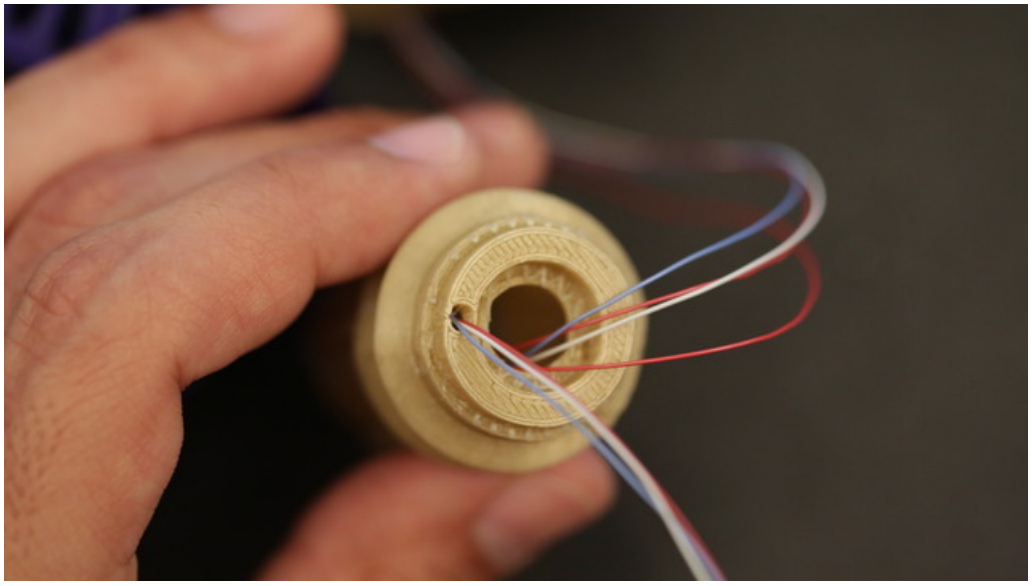
The **flir-handle-btm.stl** and **flir-handle-top.stl** parts snap together. Before closing them shut, ensure the three wires to the NeoPixel ring are strung through the opening near the top hinge. Be careful not to kink the wires. The **flir-handle-light.stl** snaps to the joined handle piece. To secure this piece to the handle, insert a piece of a paper clip into the hole located in the middle of the hinge where they meet.

The Ray Gun

3D Printed Parts
There are 10 pieces to the ray gun. This is a great print if you're really ambitious about 3D Printing. The **raygun-neck.stl**, **raygun-handle-top.stl**, and **raygun-handle-btm.stl** parts require support material to print properly.

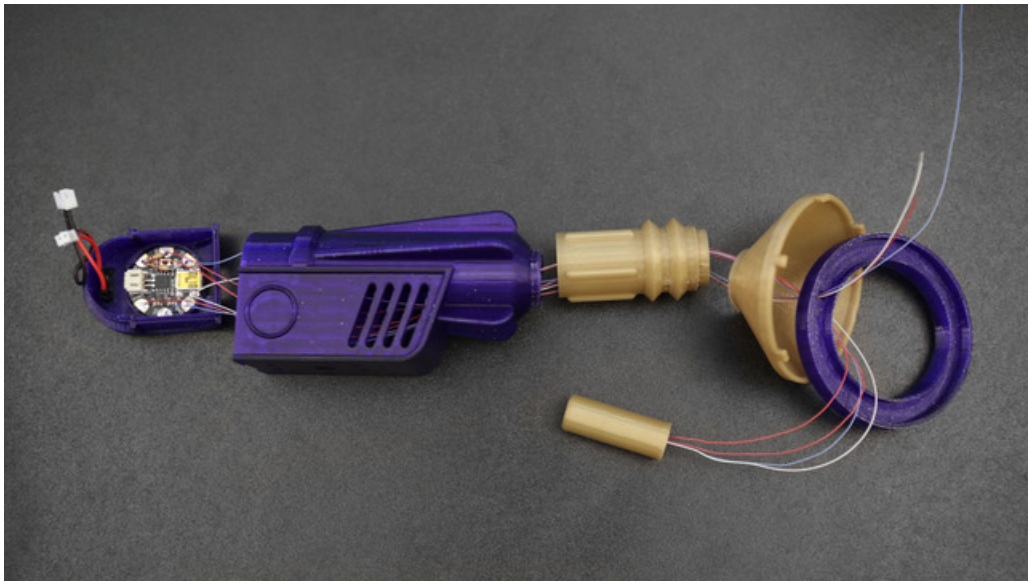
Once you have them all printed out, test fit them to see if the tolerance allow for a snap fit. If things are too tight, you can always try sanding down areas to allow assembly. Below is a list of parts that fit to one another.

- raygun-cap.stl > raygun-body.stl
- raygun-neck.stl > raygun-body.stl
- raygun-cone.stl > raygun-neck.stl
- raygun-sensor.stl > raygun-cone.stl
- raygun-ring.stl > raygun-cone.stl
- raygun-handle-top.stl > raygun-handle-btm.stl
- raygun-handle-lid.stl > raygun-handle-top.stl
- raygun-handle-top.stl + raygun-handle-btm.stl > raygun-body.stl
- raygun-diffuser.stl > raygun-ring.stl



MLX90614

The temperature sensor is inserted into the **raygun-sensor.stl** part with the orientation aligning up with the slit opening for the sensors nub. Use a long thin screw driver to gently press against the sensor, securing into place.

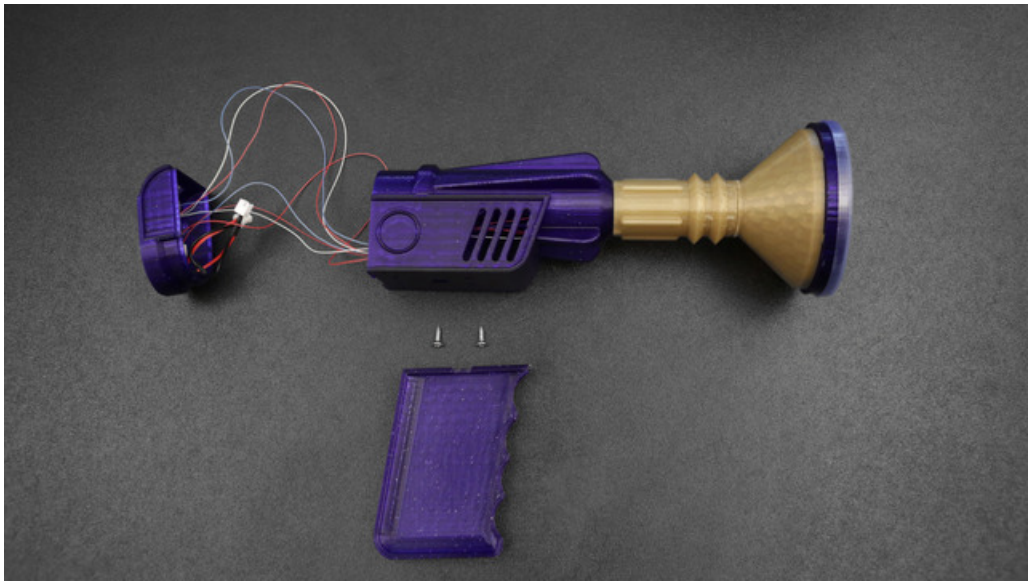


GEMMA

The micro-controller snaps to the inside of the **raygun-cap.stl** with the USB port facing the large opening for reprogramming without disassembly. The slide switch adapter tightly fits into the opening of the **raygun-cap.stl**, just above the **GEMMA**.

NeoPixel Ring

The wiring needs to be long enough to run from the **raygun-cap.stl** to the **raygun-body.stl**, strung through the **raygun-neck.stl** and strung through the small hole of the **raygun-ring.stl**. The wiring should be exposed on the **raygun-cone.stl** part.

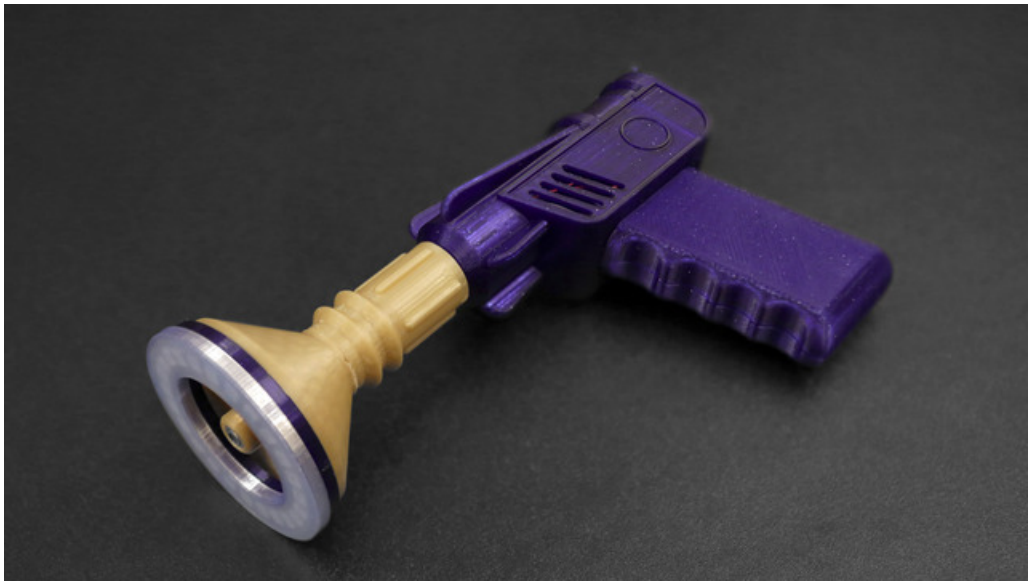


Assembling the Handle

The **raygun-handle-top.stl** and **raygun-handle-btm.stl** pieces snap fit together. Both parts have 2mm holes for small screws that will mount the two parts to the **raygun-body.stl**

3X AAA Battery Holder

The two handle parts and the **raygun-body.stl** have a large hole, this allows the battery JST wire to run through the parts and is connected to the slide switch adapter that is mounted to the **raygun-cap.stl**. The **raygun-handle-lid.stl** part is secured to the **raygun-handle-top.stl** with 2 small screws.



Ray Gun
The fully assembled model is a challenging project but definitely reproducible. Each piece is hollow and optimized for sturdiness.