# Portable Electroretinography (ERG) Goggles for use in the Pediatric Surgical Suite

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## BACKGROUND

The Department of Pediatrics uses electroretinography (ERG) at the American Family Children's Hospital (AFCH) to non-invasively assess visual functioning. ERG involves flashing light for a specific wavelength, duration, frequency, and intensity, and using electrodes to measure the resulting voltage generated by the retina.

The current procedure requires blacking out all lights within the OR and providing any necessary light sources with red light filters. This requires ~45 minutes extra time where the OR is unavailable and also requires the operating room staff function in darkness with only minimal red lights.

The proposed device will incorporate well-established ISCEV ERG protocols into a portable medical device that can be used in the operating room environment.

## METHODS

**Rapid prototyping:**
- Creality Ender-3 3D printer
- Silicone for flexibility and facial form fitting
- PLA and TPU filaments as needed
- 6080 White Reflectance Coating

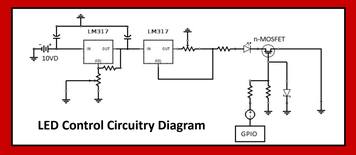
**Critical Electronic Hardware:**
- Cree Xlamp CM-E RGBW LEDs
- Cree IR LEDs
- Raspberry Pi 4 8GB RAM Model B
- Raspberry Pi NoIR Camera Module V2
- LM317 Linear Voltage Regulators
- 10KΩ Trimmer Potentiometer
- IRLZ44N N-channel MOSFET
- Customized PCBs designed with EasyEDA

**Software Design and Control:**
- SolidWorks for digital design
- Ultimaker Cura to convert SolidWorks designs into 3D printable code
- Use Pulse Width Modulation to regulate duty cycle and thereby LED intensity
- Basic GUI design using Python and Tkinter library

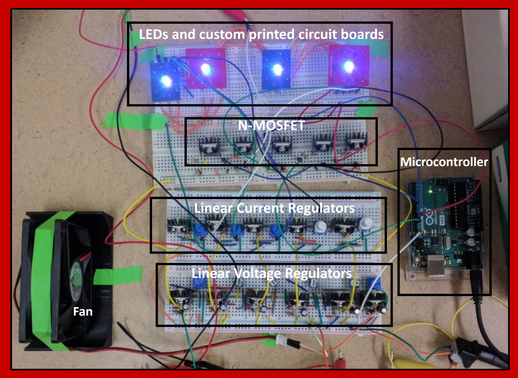
## Results

### Electronics

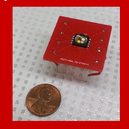
RGBW LED




LED Control Circuitry Diagram




LED on printed circuit board (PCB)

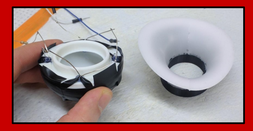


Raspberry Pi 4 model B Computer

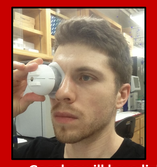
### Goggles

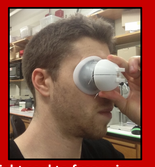
Picture of eye using IR LEDs and IR camera

IR Camera



Eye piece and cap separate

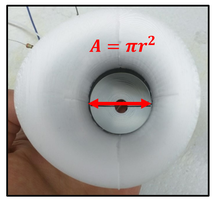




Goggles will have light-tight seal to face using molded silicone

## Desired Design Outcomes

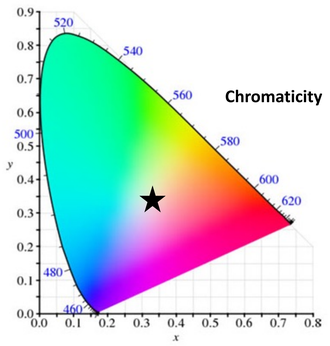
**LED Intensity:**
- Need to meet the following frequency and light intensity criteria:
  - **Flash intensity:** 0-10 cd*s/m²
  - **Flash frequency:** 0-30 Hz
  - **Background Intensity:** 0-30 cd/m²
  - **Chromaticity:** (0.33, 0.33)




**Graphic User Interface:**
- Allow user to switch between various predetermined ERG protocols and also allow for user to create customized protocols with light intensities and color combinations of their choosing.
- On-screen camera display of eye confirming that eye is open during testing.

**Goggles:**
- Eyepieces must be reusable and sterilizable.
- Eyepieces must provide an adequate facial fit.

**Cap:**
- Must refract light uniformly into the eye.




## Next Steps

**LED Intensity:**
- Calibrate LEDs to appropriate intensities by varying current and using Pulse Width Modulation (PWM)

**Electronics:**
- **Hardware**
  - Create PCB to for RGBW and IR LEDs to fit onto cap
  - Housing for Rasp Pi and LED hardware
  - Touchscreen for Rasp Pi
- **Software**
  - Program Graphic User Interface (GUI) to control and program LEDs

**Goggles:**
- Optimize facial fit
- Connect eye piece into goggles
- Optimize refractive cap to allow for PCB fitting and electronics housing

## ADDITIONAL KEY INFORMATION

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