IDENTEC

OraLite System

Damian Kayra, Leo Lee, Harrie Sidhu, Rex Xue

IDENTEC Team

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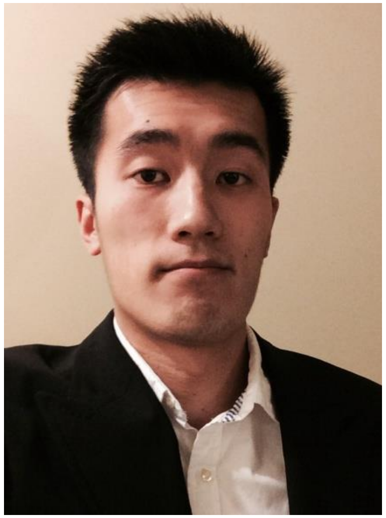
- Damian Kayra
  - Chief Executive Officer

- Leo Lee
  - Chief Technical Officer



IDENTEC Team

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- Harrie Sidhu
  - Chief Operating Officer

- Rex Xue
  - Chief Financial Officer

Composite Fillings

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- Most common type of filling material used in developed countries
- More than 100 million composite fillings placed each year in North America
- Average life of a composite filling is approximately 8 years
- Very difficult to visually distinguish composite material from tooth

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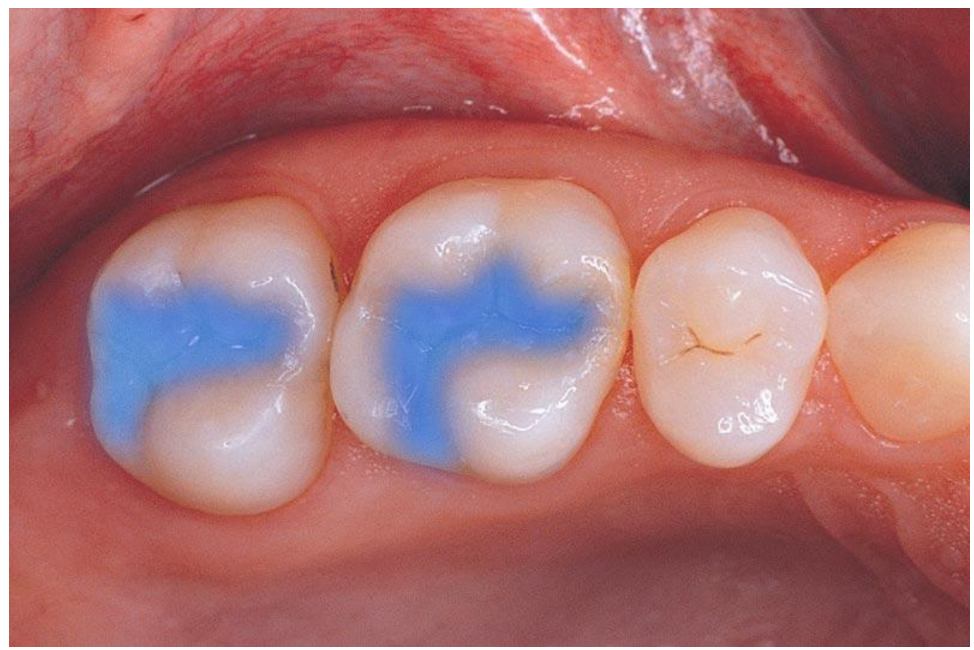
Project Goal

To develop a working prototype that allows the user to visually differentiate between tooth material and composite fillings.



Project Guidelines

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- The system should be easily integrated with current dental optics
  - Run off currently used power supplies
  - Adaptable to dental loupes
- The system must be easy to use and not hinder the user in other tasks
- The system will use passive optics to visually enhance the composite fillings
- The system will be safe to use for extended periods of time
  - Safety goggles
  - Thermal considerations

Budget & Actual Expenditure

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- Fund from ESSEF **($750)**
- Actual Expenditure **($760)**

No.	Item	Cost	Notes
#1	425 Longpass Filter X2	$230.00	
#2	Clear Loupe Covers	$10.00	
#3	20mm Optical Lens	$50.00	
#4	Custom Heat Sink	$35.00	
#5	405nm Laser Diode X2	$110.00	**One got damaged**
#6	Bandpass Filters (450/80nm & 460/60nm)	$130.00	
#7	395-405nm 30mA LEDS	$40.00	
#8	405nm 2W & 5W LEDS	$120.00	
#9	Miscellaneous - Electronic & Mechanical	$35.00	
	Total Expenditure	***$760.00***	

Build of Material Cost

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Item	Manufacturer	Cost for Prototype	Cost for Mass Production
425 Longpass Filters	Edmund Optics	$230.00	$200
Clear loupe covers	Henry Shein	$10.00	$5
20mm Optical Lens	Edmund Optics	$50.00	$20
Custom heat sink	Identec	$35.00	$10
405nm Laser Diode	US-Lasers	$55.00	$30
Miscellaneous		$15.00	$5
Labor			$10
	Total Amount	**$395.00**	**$280.00**

- For mass production, estimate cost to be cheaper than the prototype due to bulk orders
- Assume that we sell $1000 per unit to 20% of dentists in Canada (January 2010 – 19,563 licensed dentists), we can make approximately $2.8 million!!

Schedule

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Milestone	Projected Milestone Date	Realized Milestone Date	Comments
Project Planning/Proposal	September 26	September 26	
Functional Specs	October 17	October 17	
Group A - Spectrographic Analysis			
Group B - Mechinical Adapters Research			
Design Specs	November 14	**November 17**	Extend 3 days for revising mechanical adapters
Group A - Design & Build Optical Parts			
Group B - Design & Build Mechanical Adapters			
Integration / System Testing (Group A+B)	November 18	November 18	
System Modification & Testing on Extracted Teeth Samples	November 25	**November 21**	
System Modification for Electronic Circuit	December 6	December 6	Added for revising the circuit
Demo	November 27	**December 11**	Postponed for revising the circuit
Post-Mortem + Minutes	After Demo Day		

Encountered Issues

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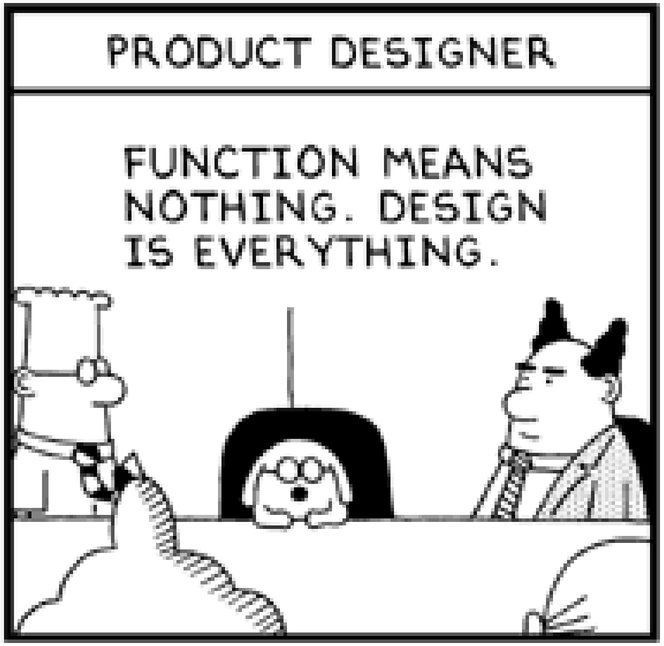
Three Highlighted Issues:

1. **Repeated paperwork on documentation**
   - Direct communication, not by email. Also immediately notify members for changes

2. **Disagreement on the model of mechanical adapters**
   - Group Discussion & Analysis – reduce fractions to simplest.

3. **Lack of sufficient electronic components**
   - Review the whole system and add LM555 timer and transistors

Design of the OraLite System



Overview

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Three Main Components:

1. Light Source
2. Optical Filters
3. Mechanical Adapters

A) Optical Team

B) Mechanical Team

Optics Team

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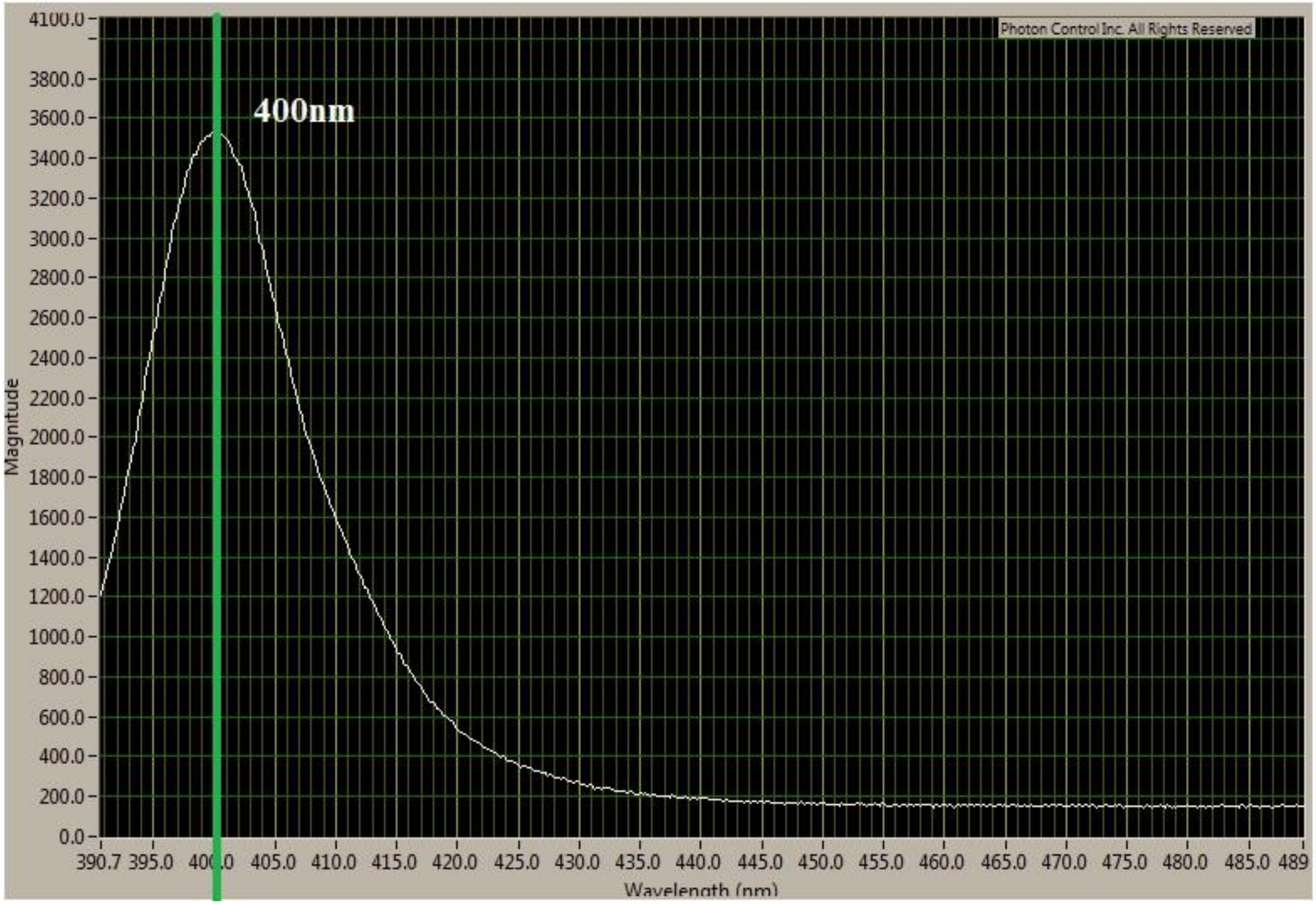
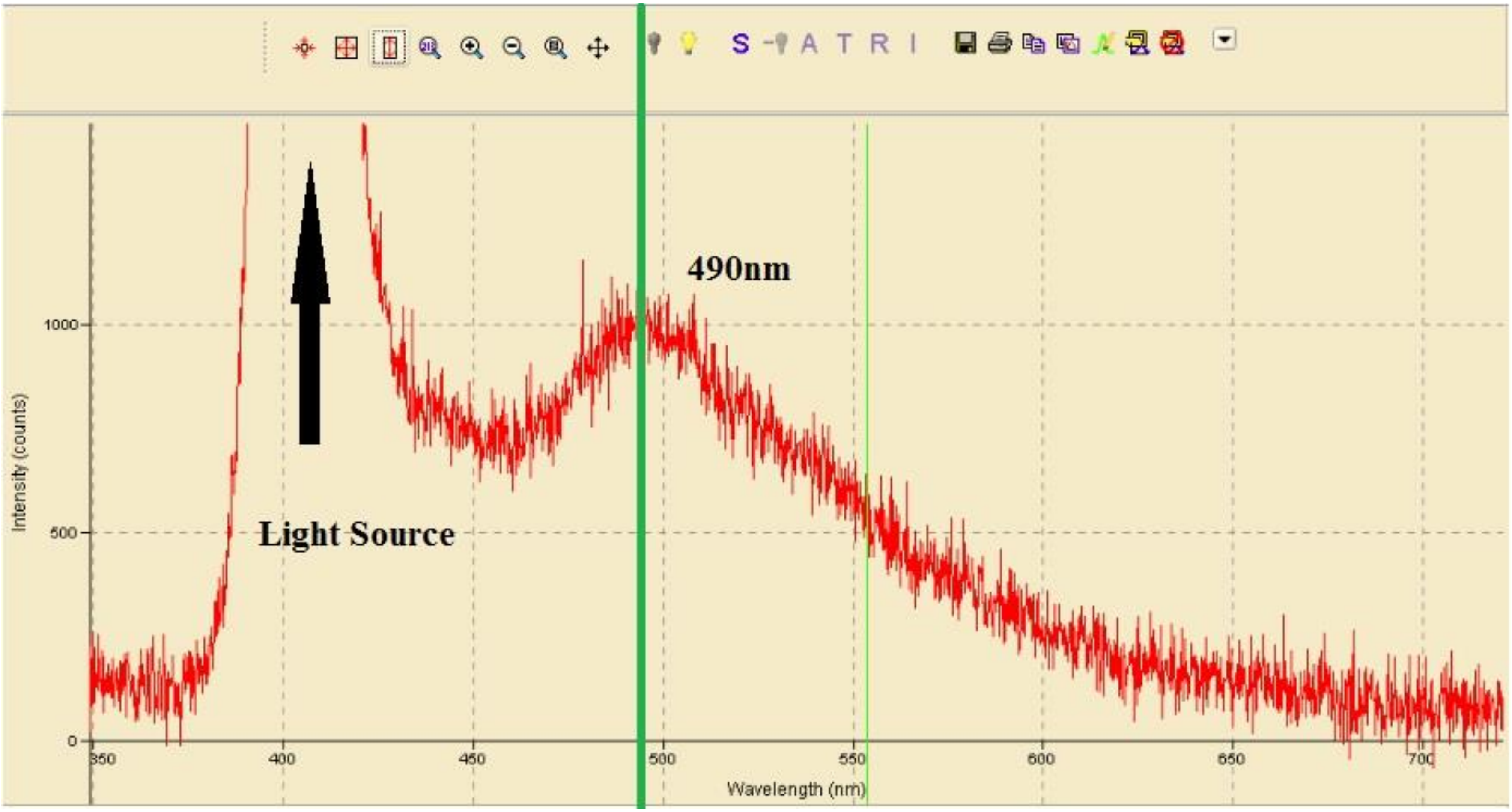
- Optical and fluorescence properties of tooth and composite
- Tested in the SFU Optical Lab
- Tooth and composite sample preparation
- Blue light (used in oral cancer diagnosis)
- Ultraviolet light
- No filters but tested with polarized film

UV Flashlight



Composite Fluorescence



Inside Molar Fluorescence

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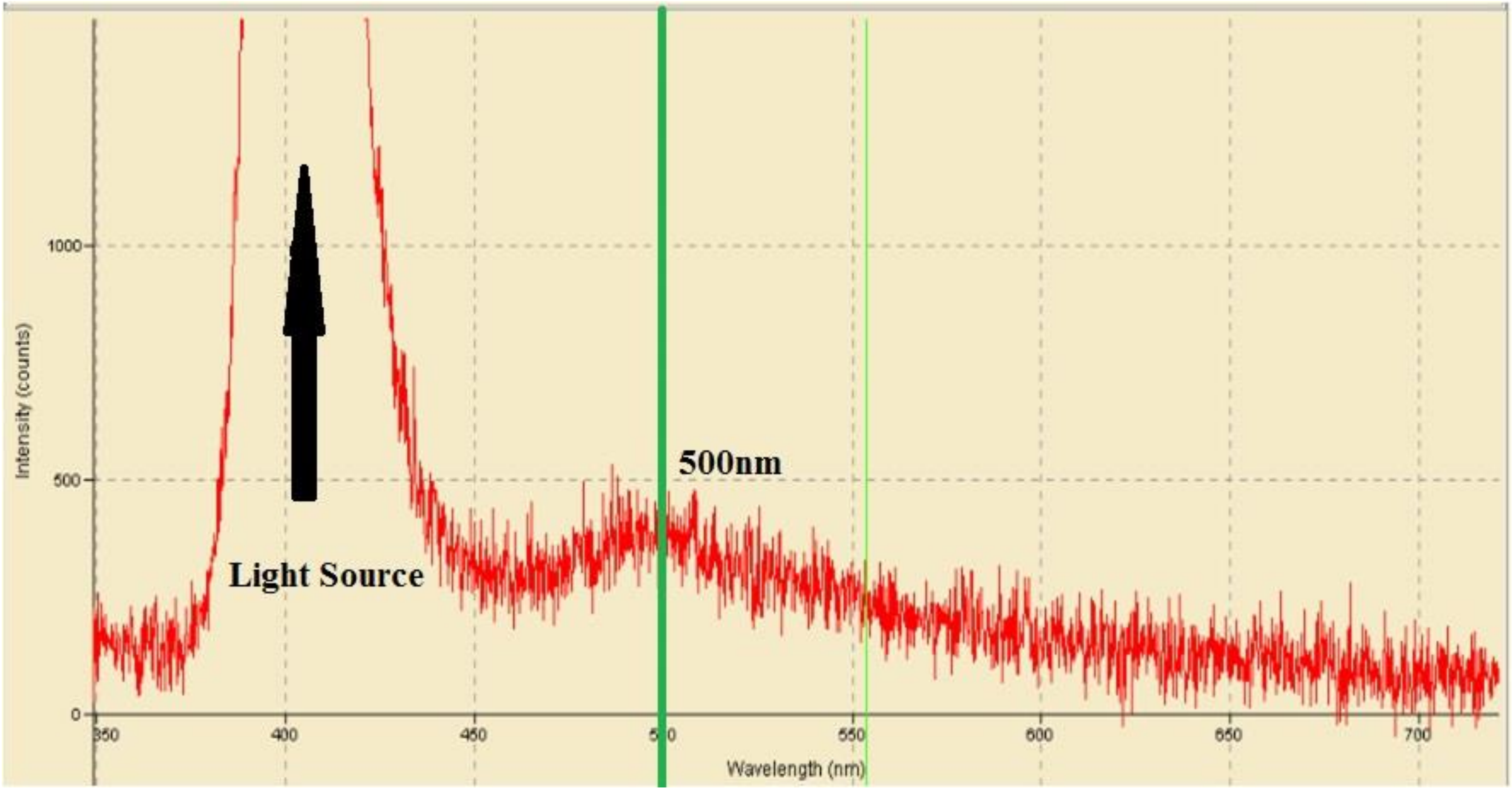

Initial Filter Selection

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- Purchased Semrock 460/60 Brightline optical filters (430-490nm) with 90% transmittance
  - Cost per filter => $260
- Purchased Edmund Optics 450/80 optical filters (410-490nm) with 60% transmittance
  - Cost per filter => $50

Light Source

- Purchased 390nm, 395nm, 400nm, 405nm and 408nm typical 30mA LEDs
  - 395nm light allow composite to fluoresce the best
  - Safety concerns -> 405nm LEDs
- Not bright enough!
  - Purchased 2W 405nm LEDs
- Fabricate PCB board with both 405nm LED and white LED as light source

2W 405nm LED

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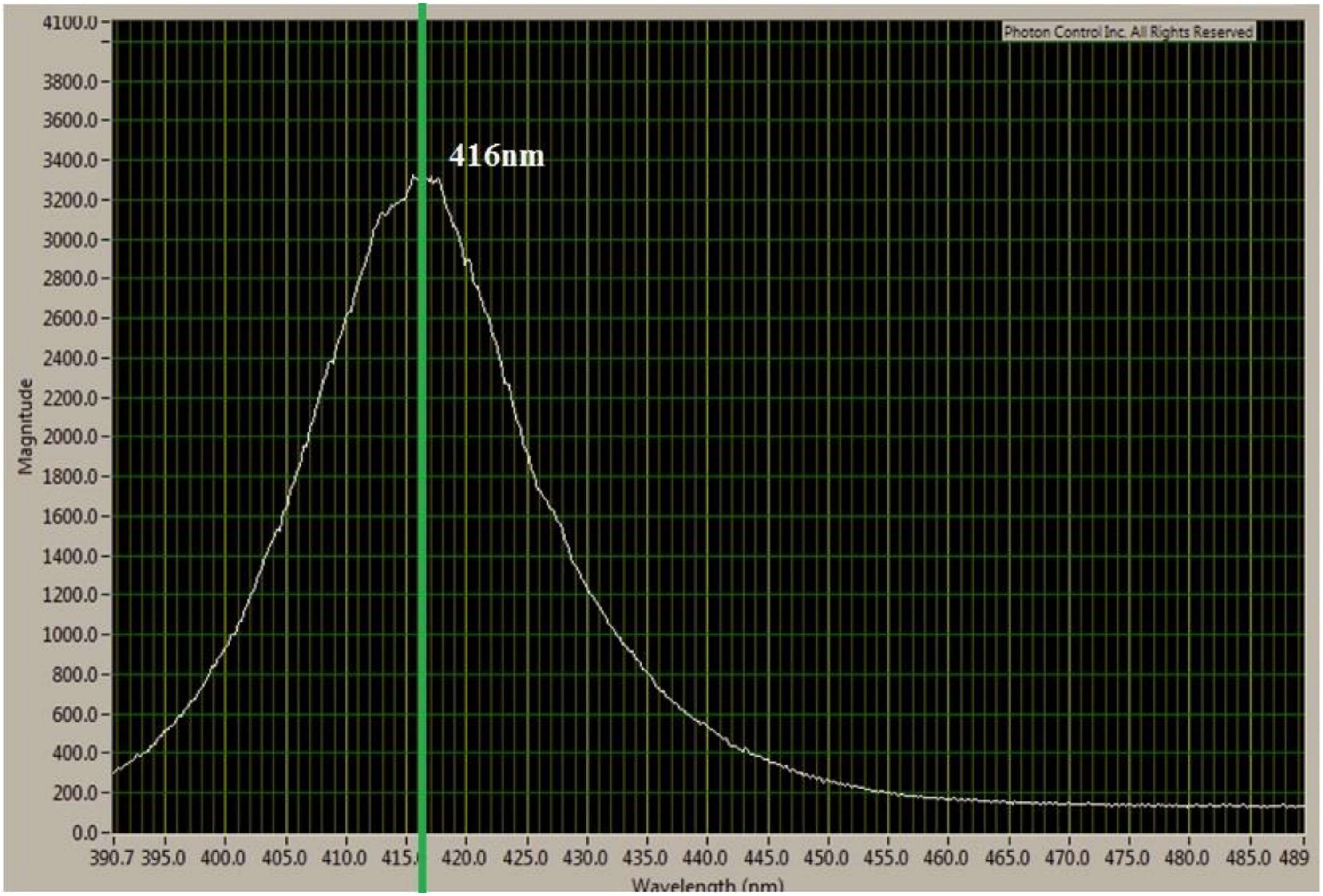

5W 405nm LED

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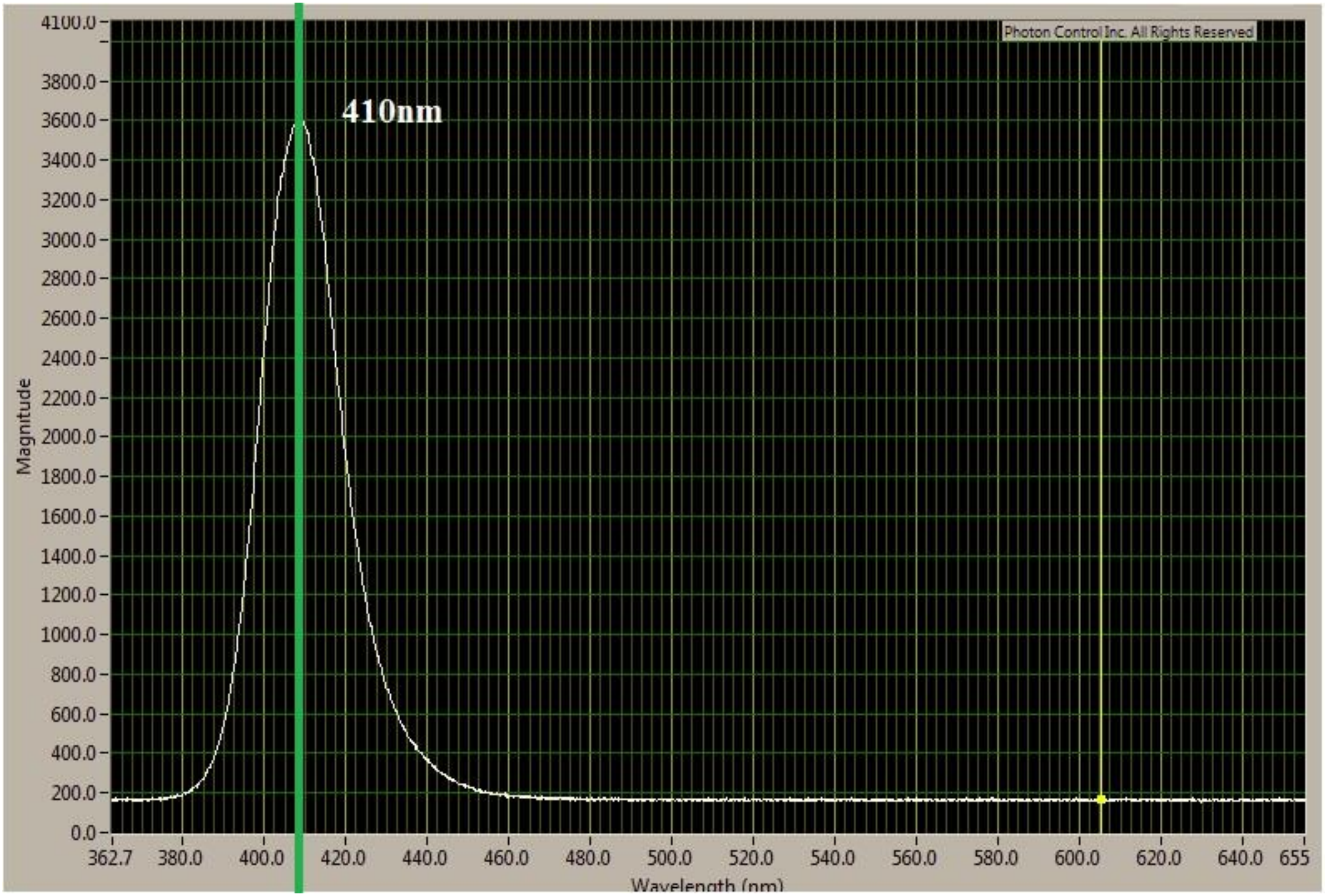
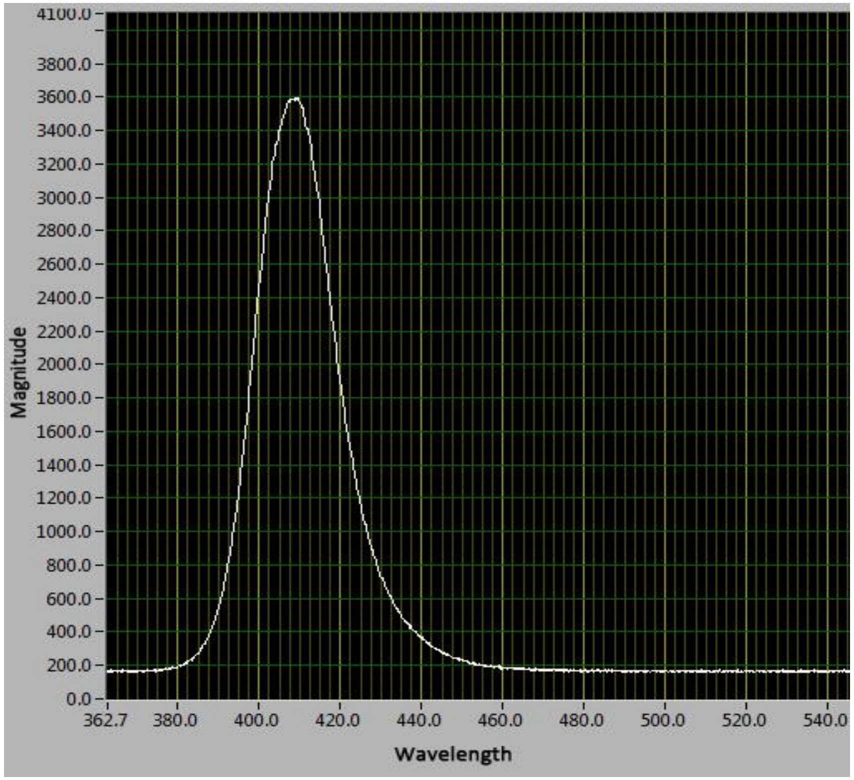


Original Concepts: LED's

- System was originally designed to use 405nm LED's to excite fluorescence

- Advantages:
  - Cheap
  - Minimal safety concerns
- Disadvantages:
  - Heat
  - Broad spectral range
  - Power consumption
  - Low fluorescence excitation



Evolved Concepts: Laser Diodes

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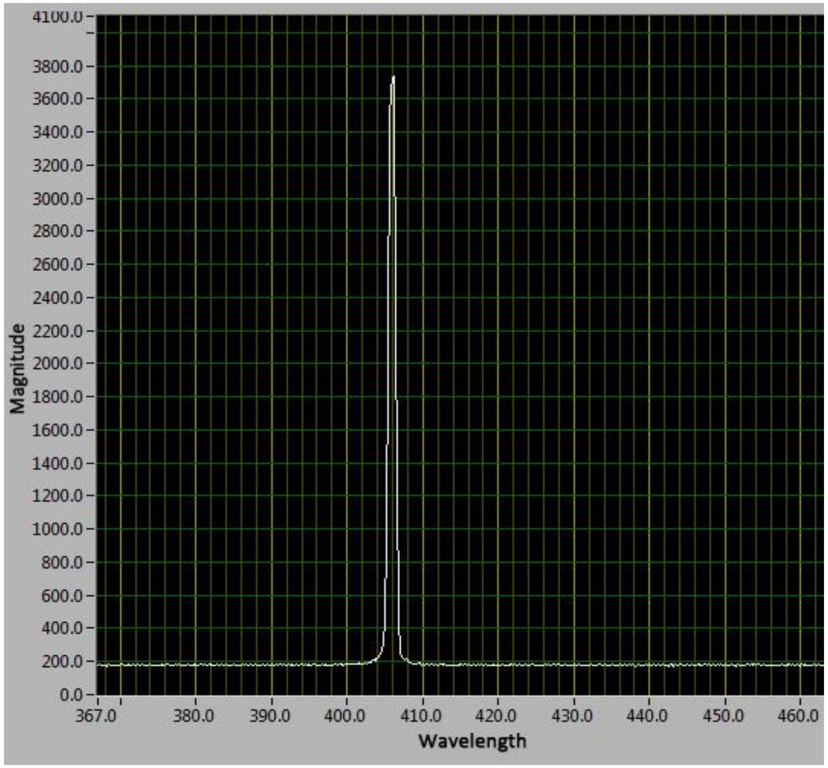
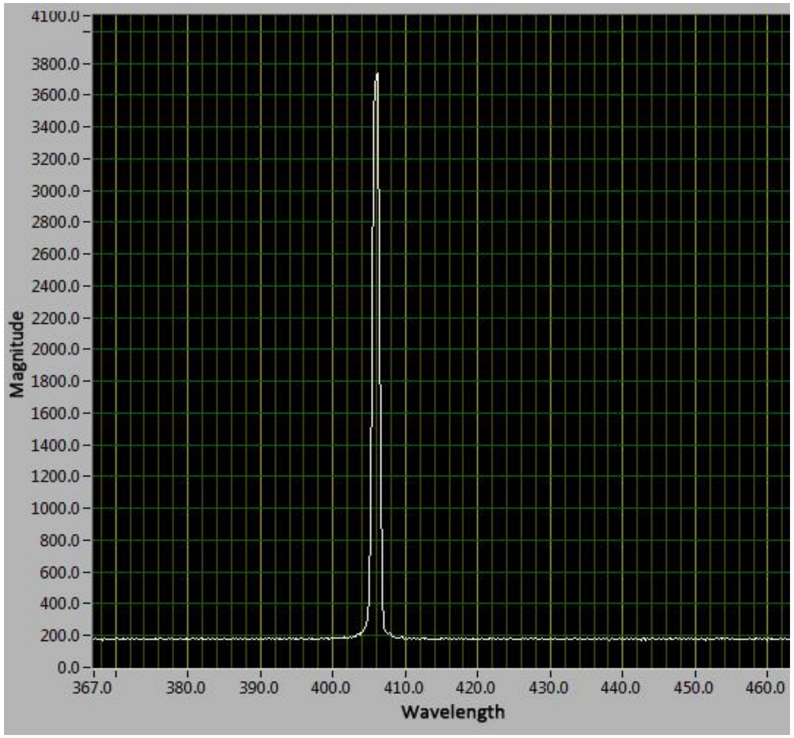
- Light source changed to 405nm Laser Diode

- Advantages
  - Low power consumption
  - Narrow spectral range
  - Generates less heat
  - Excellent fluorescence excitation
  - Collimated beam
- Disadvantages
  - Requires a heatsink
  - Safety

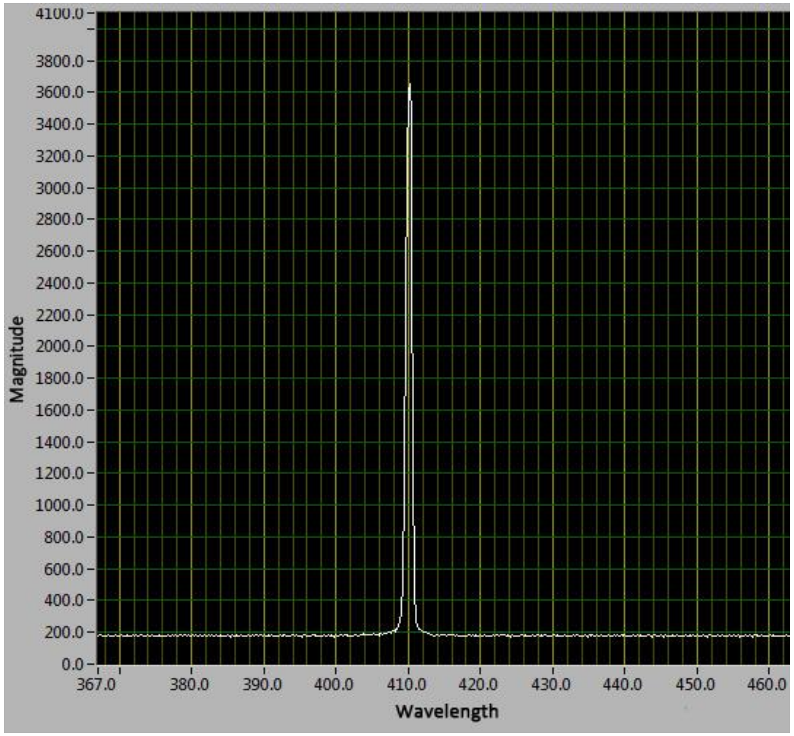


Laser Diode – Heatsink Justification

- The laser diode heats up to 60°C after five minutes of operation at room temperature
- As the diode heats up, the laser spectrum shifts to a longer wavelength
- At around 410nm center wavelength, fluorescence emission is cut in half



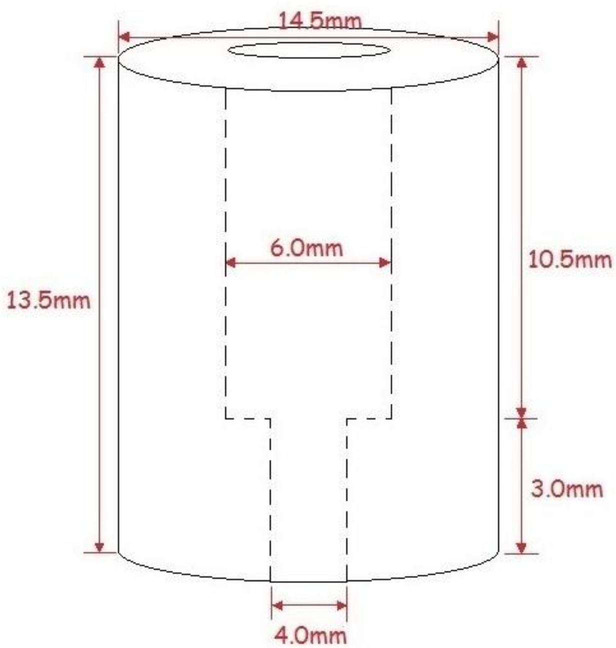
Laser Diode after 1 minute



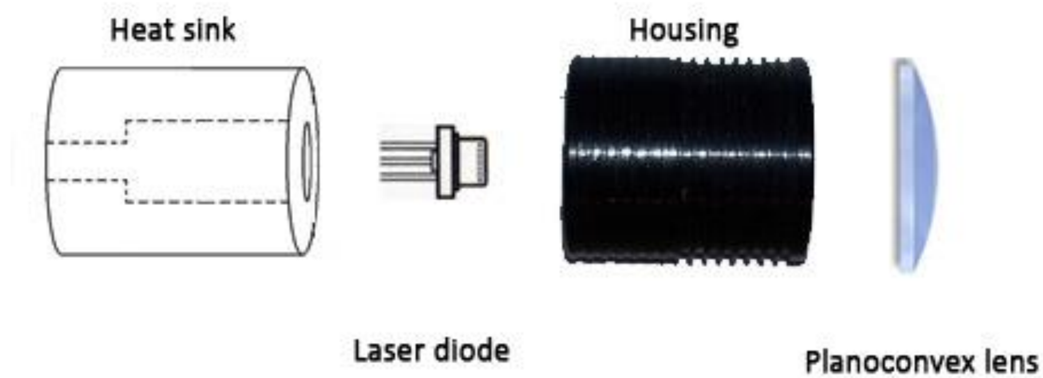
Laser Diode after 5 minutes

Heatsink Design

- Aluminum was chosen as the heatsink material
  - Lightweight
  - Excellent thermal conductivity

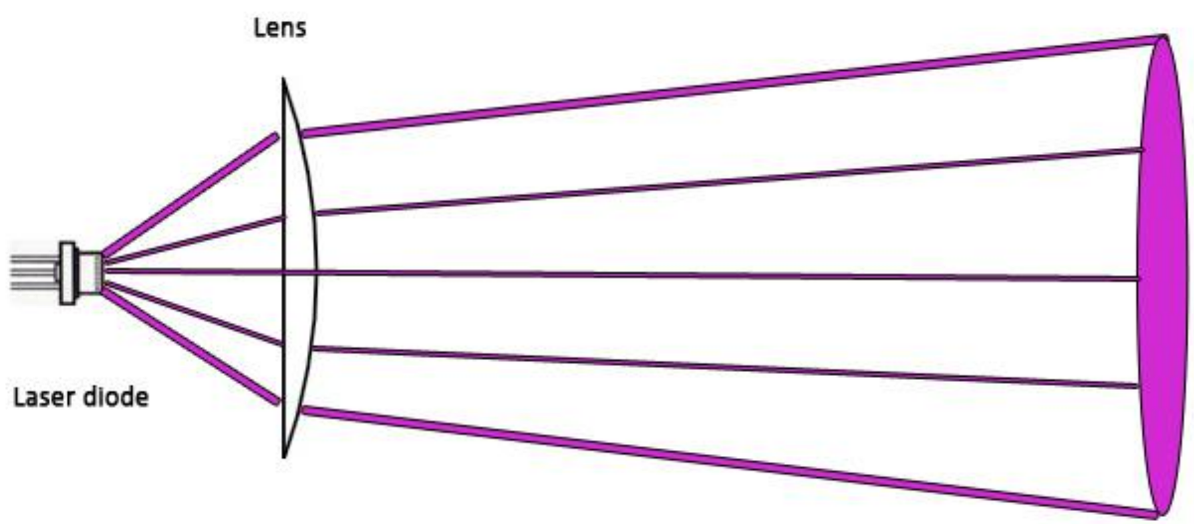


Side View



Planoconvex Lens

- Need to slow the rate of divergence of diode laser beam
  - Lower optical intensity at distance means less fluorescence
  - Cannot focus the beam along its path
- Use a planoconvex lens with a short focal length (18mm) and place the laser diode inside the focal length



Optical Filter Design

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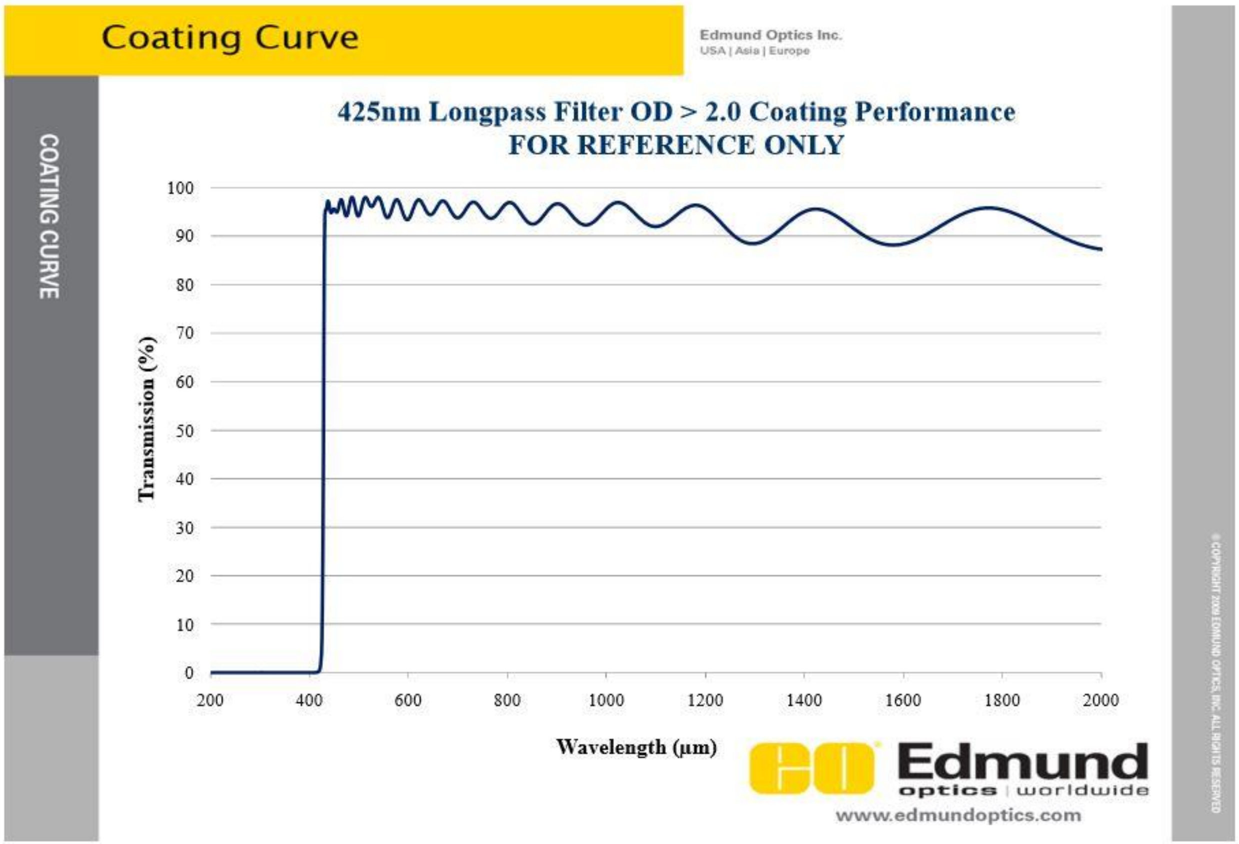
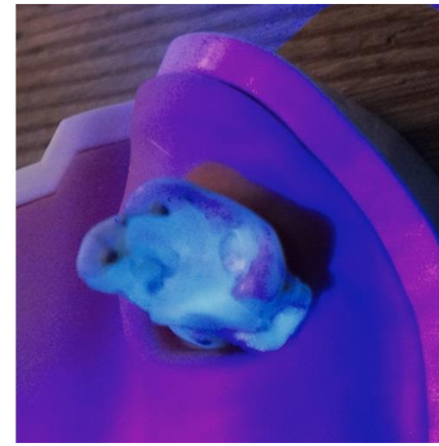
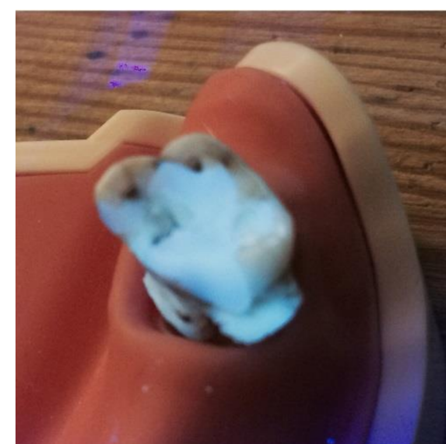
- Optical filters to remove laser light from users vision
  - Enhance visual contrast of composite fillings from surrounding material
  - Safety
- Filter should not obstruct users vision when system is not in use
- Filter needs to have >90% transmittance in desired range
  - Light loss of approximately 5% per surface between object and user
- Filter should block >99% of laser light to user

Optical Filter Design





Without Filter



With Filter

www.edmundoptics.com

Intensity Ratings

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Light Source	Power Ratings
Eye Safe	1mW/cm2
OraLite System	17.4mW/cm2
Cellphone Camera light	11mW/cm2

- OraLite eye safe 30cm away from the eye
- Solution: Modulating circuit
  - Fluorescence excitation lifetime
  - Lower intensity of the light source
  - Save battery power

Circuit Specifications

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- 555 Timer
  - 55Hz at 55% duty cycle starting point
  - Use iterative design to optimize the power output
- Current Regulator
  - Ensure laser diode operating conditions when battery is low on power
  - Constant 50mA current

Calculations

Average Power:

$$P_{avg} = P_{peak} \times DutyCycle$$

$$P_{avg} = 17.4mW / cm^2 \times 55\%$$

$$P_{avg} = 9.57mW / cm^2$$

555 Timer Equations:

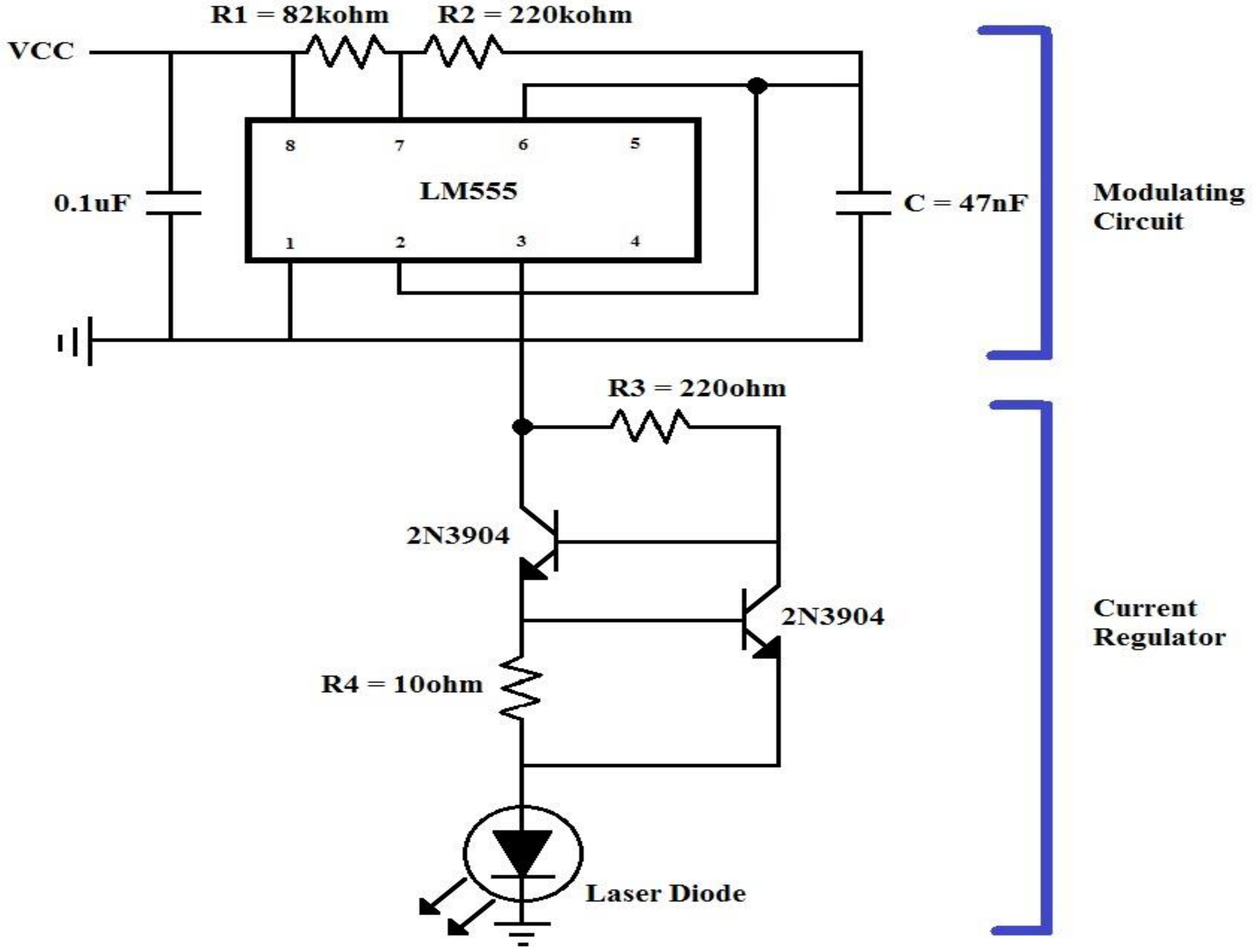
$$Frequency = \frac{1}{0.693 \times (R_1 + 2R_2) \times C}$$

$$OnTime = 0.693 \times (R_1 + R_2) \times C$$

$$OffTime = 0.693 \times R_2 \times C$$

$$DutyCycle = \frac{R_1}{R_1 + 2R_2} \times 100\%$$

Circuit Design



Integration Problem

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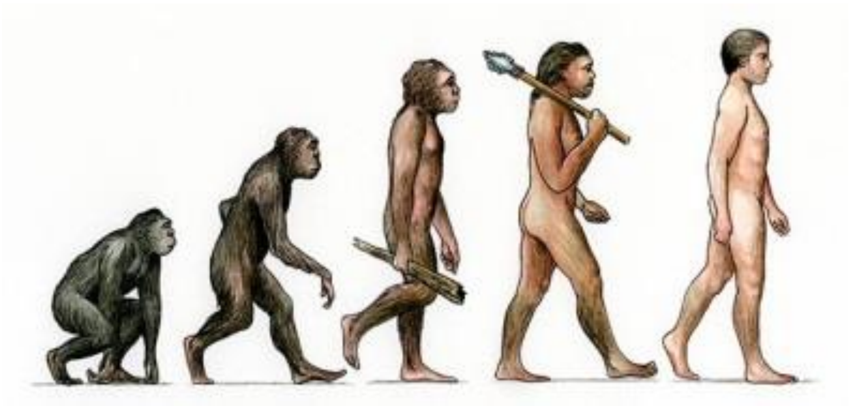
- The Feather Light LED battery pack has a LED driver installed
  - Voltage regulator
  - Cannot power the LM555 chip
- Solution: Use a 12V battery (9V in series with two AA battery)

- Another Problem: Power intensity could not be measured because the light was pulsing

Mechanical Adapters - Evolution



Mechanical Team – Swivel System

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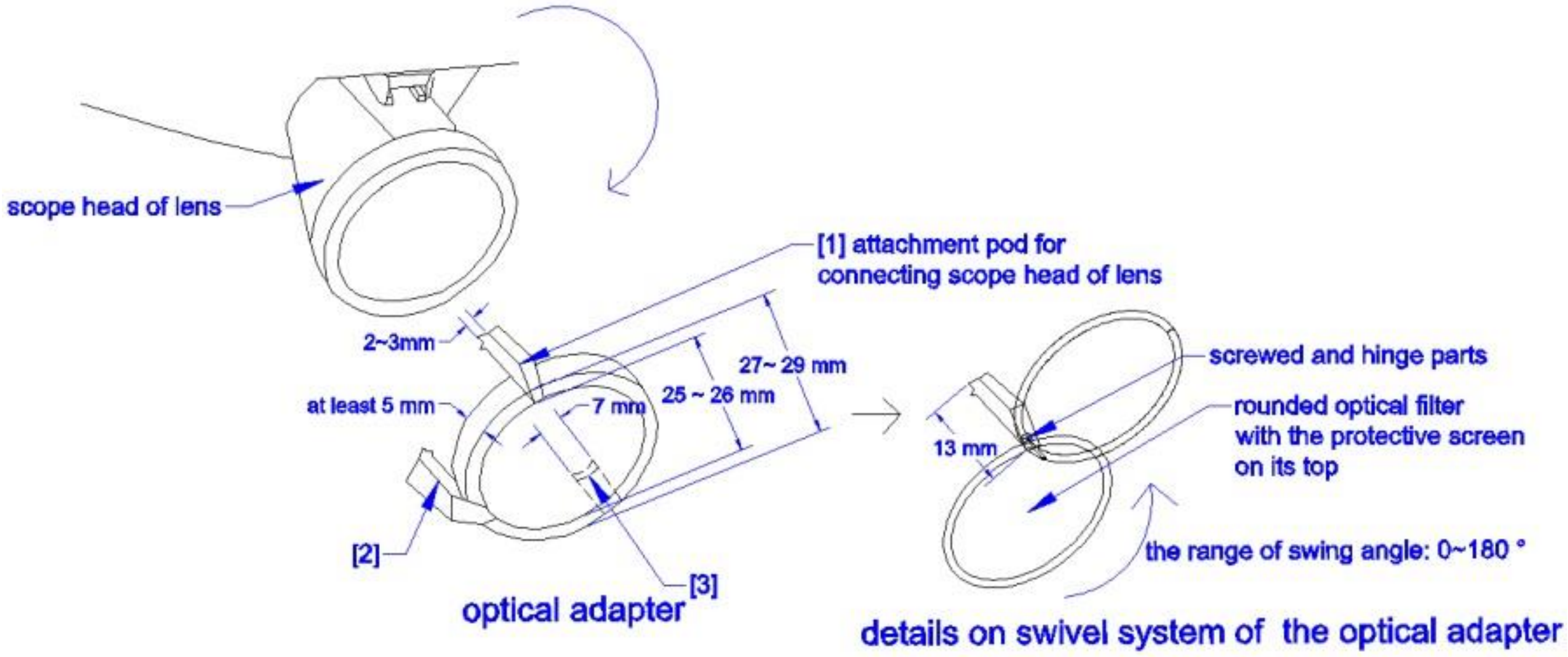
- The originally proposed design
  - The Swivel System



Note: [1], [2], [3] are the same type of attachement pods

Swivel System

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- **Method we tried to mount the swivel system onto the dental loupes and reasons for its failure:**
  - The Hinge and Screw method:
    - Two O-rings attached to each other
    - O-rings are free to revolve
    - Place the optical filter in the outer O-ring
    - Screw the inner O-ring into the dental loupe

Swivel System

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Reasons for the failure of the Hinge and screw method:

1. ***No feasible way of attaching the system with the dental loupes***
2. ***Limited funds***
3. ***Violates the principal of the OraLite optical system***

The above reasons forced us to abandon our Hinge and Screw system for the mechanical adapter.

Cap Model

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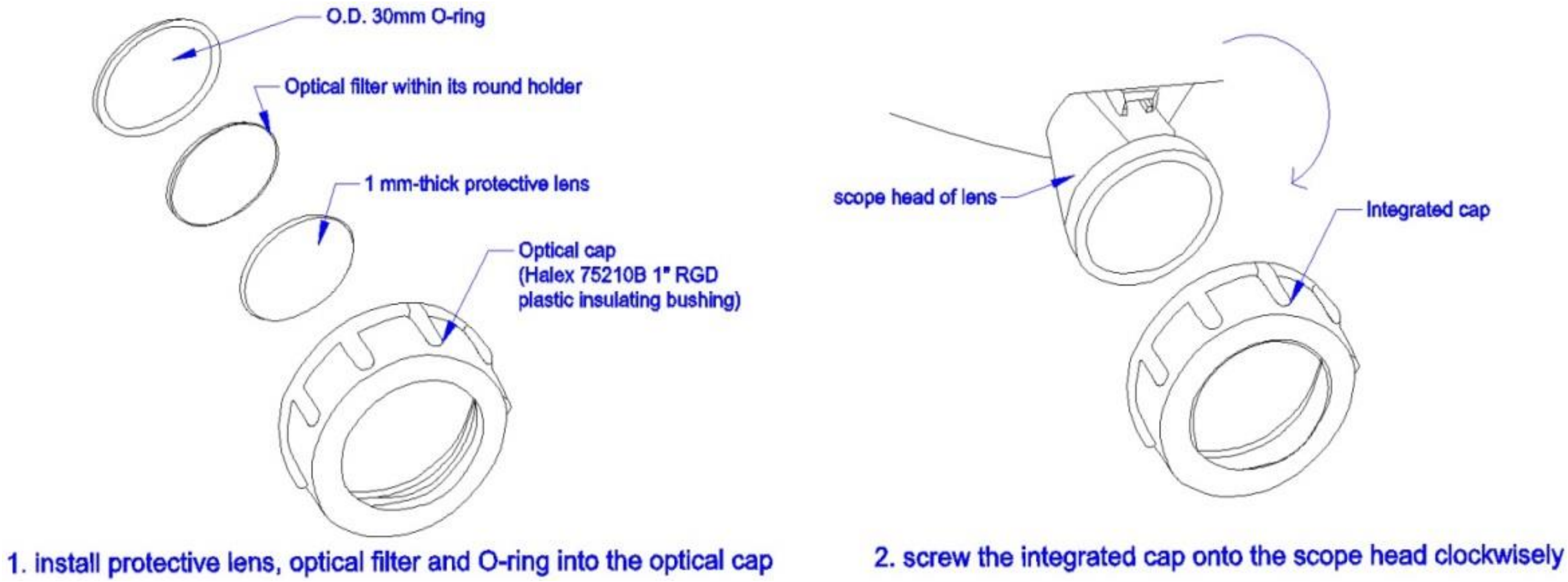
- The developed design



Cap Model

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Advantages:

Light weight, easy to assemble, secure to avoid dropping

No UV light scattering due to no swivel system

Reasons to abandon the Cap Model

1. **Inconsistent with aesthetic dentistry needs**
2. **Scratch the surface of scope heads**

The above 2 reasons pushed us to seek a better solution.

Final Design

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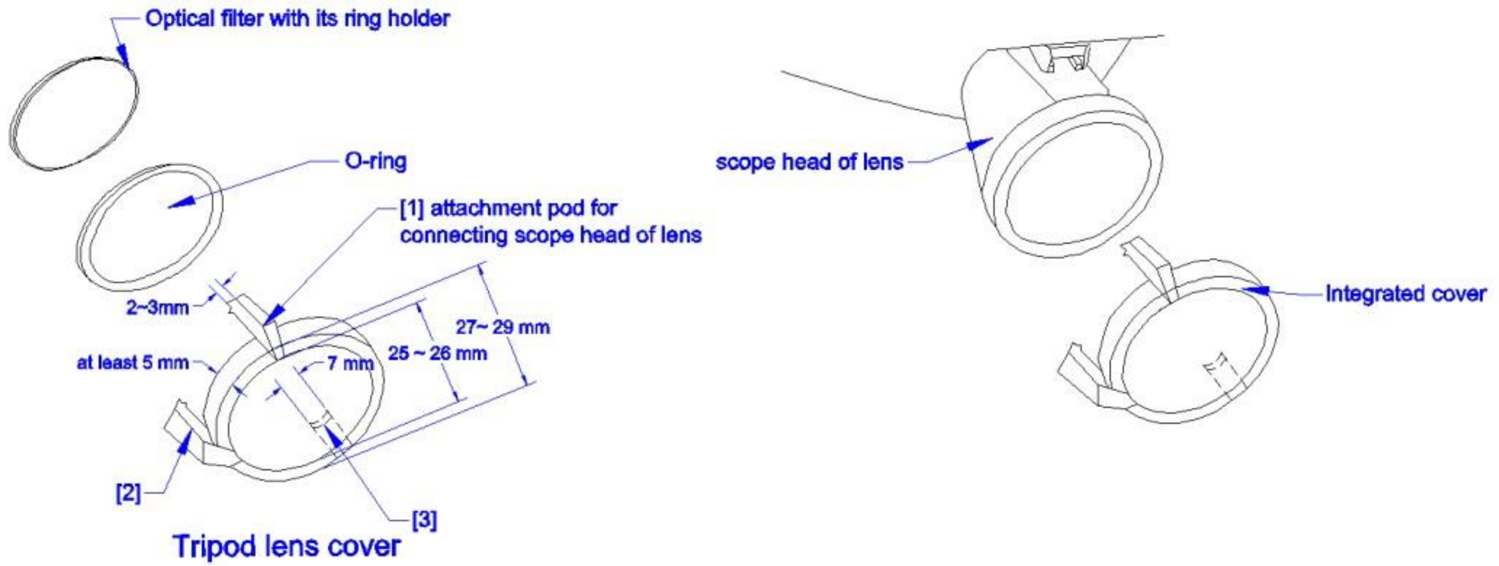
- Final Prototype
  - The Tripod Cover Model



1. install O-ring and optical filter into the tripod lens cover

2. push the integrated cover onto the scope head

Note: [1], [2], [3] are the same type of attachement pods

Final Design

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- Final Prototype
  - Absorb all merits from the cap model and reinforce them
  - Perfect tripod lens covers are available to acquire at low cost

In accordance with most principles in our OraLite system – simple, safe, light and low cost

Future Work

Future Work

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- Optics:
  - Characterise the emission spectrum of available composite materials
  - Optimise the lens to illuminate a smaller area at the working distance
  - Change optics to produce a circular laser output
    - Use a different laser diode
    - Use a cylindrical lens instead of circular
  - **Safety Testing**

- Electronics
  - Optimise modulation circuit to lower power output while maintaining fluorescence
  - Integrate system into current white-light LED systems
    - May require different power source

Demonstration

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Time to be a dentist!!

Conclusion

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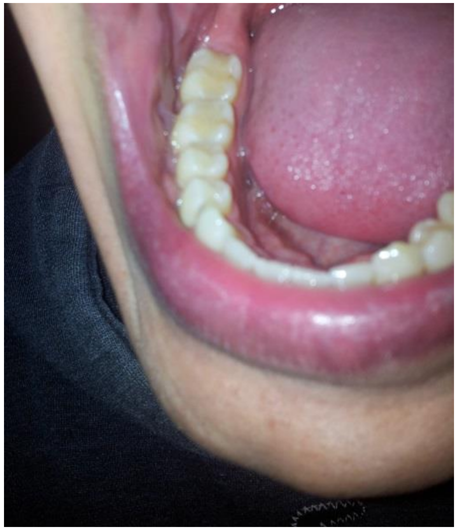
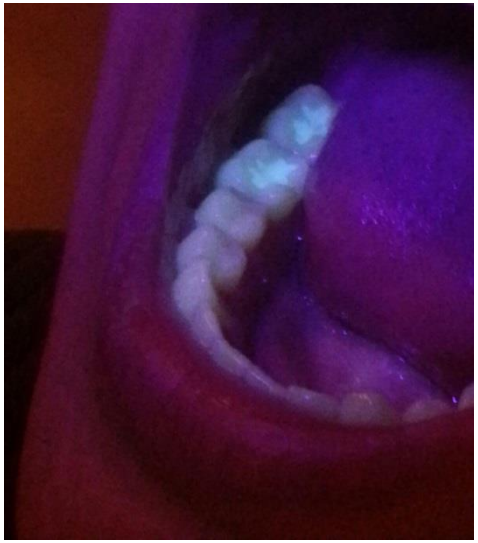
As a team we were able to develop the Oralite system from concept to working model.

There is currently no similar product available





Conclusion

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Key-point: **We are the first to implement this technology**

and that too SUCCESSFULLY

Acknowledgements

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- Special thanks to:
  - Derek Sahota
  - Marinko Sarunic
  - Michelle Cua
  - Ash Parameswaran
  - SFU mechanical shop
  - Lakshman One

Thanks everyone for bearing us for so long. Hope you enjoyed our presentation and most importantly will BUY our product

Questions??

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