Far-UVC Light in Clinical Settings

Client: Dr. Ernesto Brauer

Advisor: Randolph Ashton

Team Members: Parker Esswein, Lars Krugel, Tyler Linderman, Derick Peters, Vanessa Obrycki and Draeson Marcoux

BME Design

Our Client

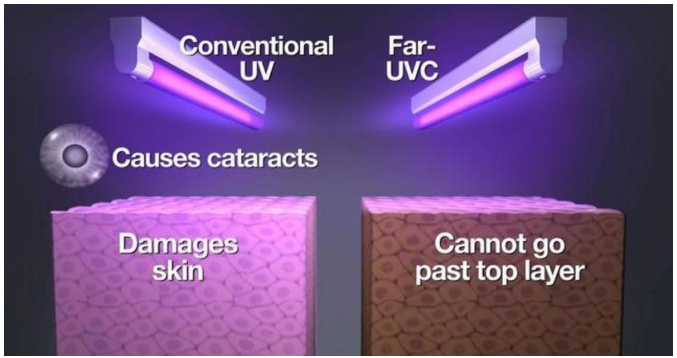
- Dr. Ernesto Brauer
- Critical Care Physician at Aurora St. Luke's Medical Center
- Personal use of UVC disinfection device
- Very hopeful for future applications of far-UVC in clinical settings

https://www.doximity.com/pub/ernesto-brauer-md

https://www.grainger.com/product/AIR-SCIENCE-Stainless-Steel-UV-Box-Sterilization-18AX46

Problem Statement and Requirements

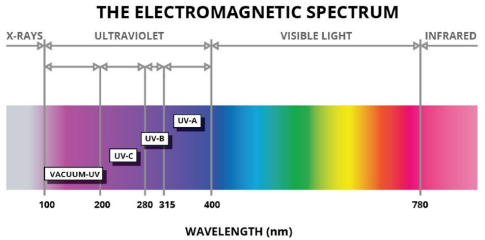
- Design and fabricate a Far-UVC light device to be used in clinical settings
  - Full room coverage
  - 99.9% effective against common household bacteria (fecal patina)
  - Safe for constant human exposure
  - Determine exposure time, distance and intensity relationship



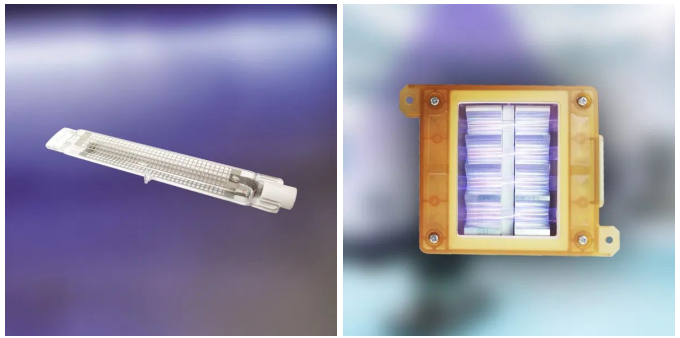
https://www.youtube.com/watch?v=8fh4LfUc-AI

Background Research

- 222 nm vs. 254 nm wavelengths (Buonanno, 2020)
  - Penetration - Living cells in the skin or eyes
- Two current studies
  - Columbia Medical Center Research (Buonanno, 2020)
    - Human Lung Cells
    - HCoV-229E and HCoV-OC43
    - 22 cm = 99.9% effective in 25 min at 1.7 mJ/cm^2
  - Hiroshima University Research Group (Hiroshima, 2020)
    - Solution of SARS-CoV-2 on a plate
    - 24 cm = 99.7% effective in 30 seconds at 3.6mJ/cm^2
- Both in vitro
- Minimal distances



https://marktechopto.com/technical-articles/understanding-ultraviolet-led-applications-and-precautions/



Ushio - 222-nm KrCl excimer lamp

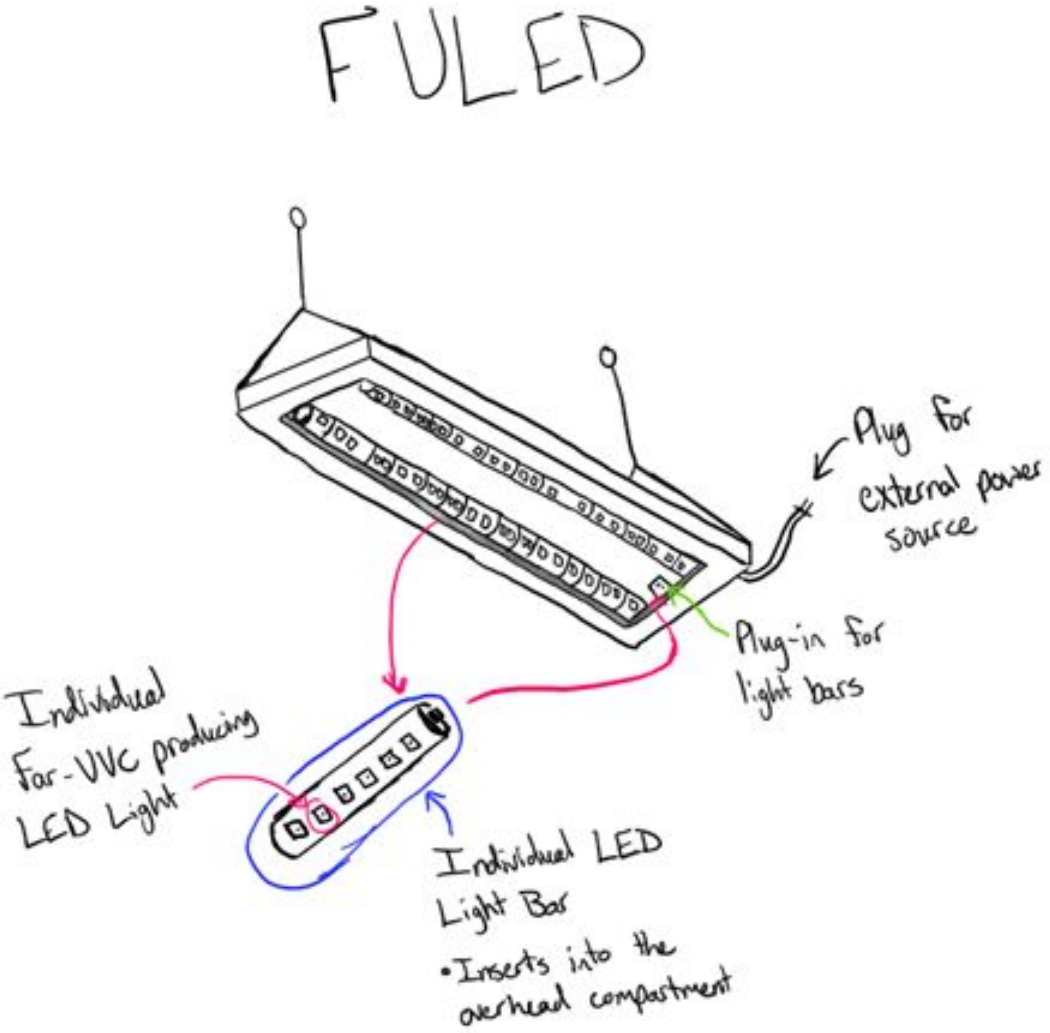
https://www.ushio.com/product/care222-filtered-far-uv-c-excimer-lamp-module/

Project Design Specifications

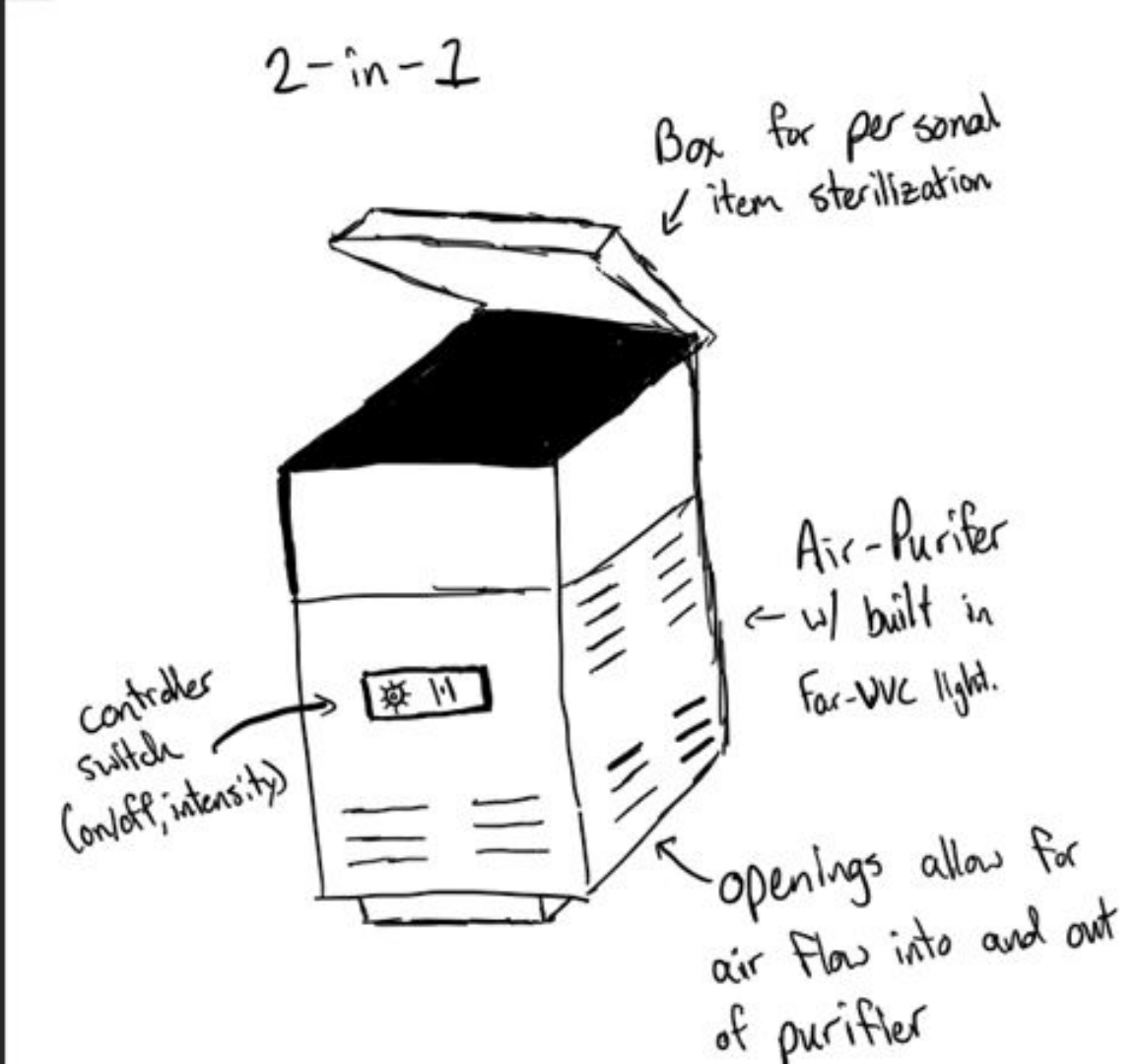
- Function:
  - Kill bacteria efficiently
  - Use of Far-UVC wavelength
- Requirements:
  - Performance
  - Safety
  - Life/Durability
  - Environment
  - Physical Characteristics
- Production:
  - Cost
  - Quantity
- Other:
  - Standards
  - Competition
  - Patient/Client Preferences

https://xtalks.com/uv-light-effective-against-mrsa-383/

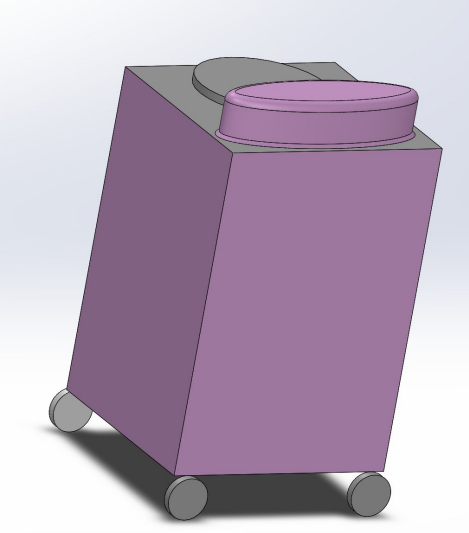
FULED Overhead Light

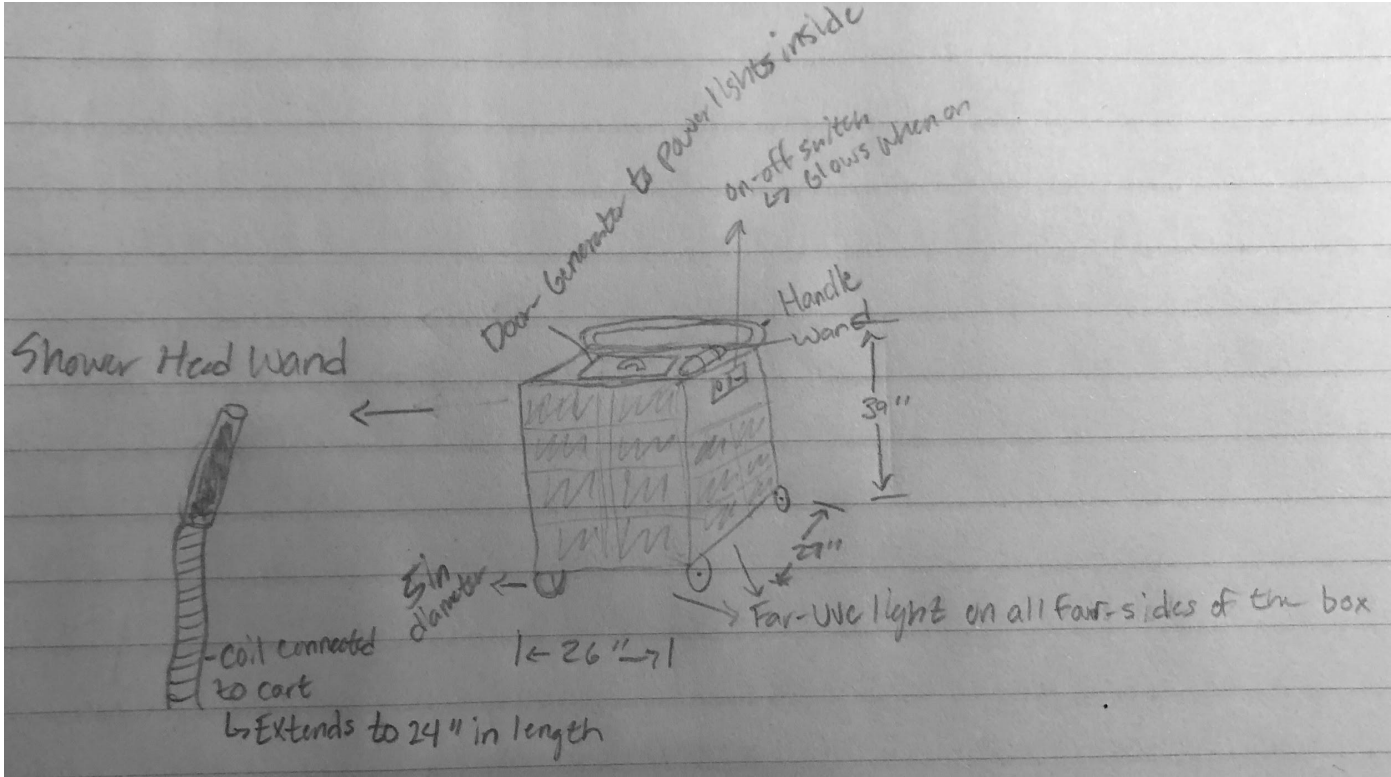


2-in-1 Air Purifier and Far-UVC Sanitation



Mobile Light Cart - easy access





Design Matrix Criteria

1. Efficacy
2. Coverage
3. Safety
4. Ease of Fabrication
5. Cost
6. Energy Usage
7. Durability
8. Ease of Use

https://hydrobuilder.com/learn/grow-light-coverage-calculator/

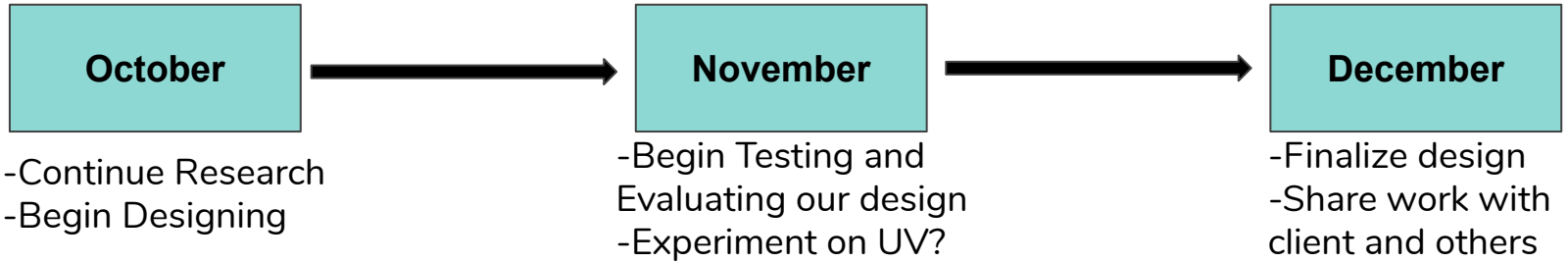
Far-UVC Device Designs

Design Criteria (Weight)	Mobile Light Cart- Easy Access		FULED Overhead Light		2-in-1 Air Purifier and Far-UVC Sanitation	
Efficacy*(25)	4/5	20	5/5	25	4/5	20
Coverage/Square Footage (20)	3/5	12	5/5	20	2/5	8
Safety (15)	4/5	12	2/5	6	4/5	12
Ease of Fabrication (15)	3/5	9	2/5	6	4/5	12
Cost(10)	3/5	6	2/5	4	2/5	4
Energy Usage (5)	4/5	4	2/5	2	2/5	2
Durability (5)	4/5	3	5/5	5	2/5	2
Ease of Use (5)	3/5	3	5/5	5	4/5	4
Total (100)		66		73		58

Design Matrix

Future Work

- Begin developing the optimal design
- Use calculations to determine:
  - Efficacy
    - Distance light travels and coverage
    - Effectiveness on different materials
    - Various shapes, angles and objects in the room
  - Safety
    - Intensity
    - Continued exposure
- Test calculations and design(s)



Acknowledgements

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References

Brenner, David. “Can Light Stop the Coronavirus?” *TED*, www.ted.com/talks/david_brenner_can_light_stop_the_coronavirus.

Buonanno, M., Welch, D., Shuryak, I. *et al.* Far-UVC light (222 nm) efficiently and safely inactivates airborne human coronaviruses. *Sci Rep* 10, 10285 (2020). https://doi.org/10.1038/s41598-020-67211-2

“Study Shows First Proof That a Safer UV Light Effectively Kills Virus Causing COVID-19.” *広島大学*, www.hiroshima-u.ac.jp/en/news/60119.