eli nuclear physics

Designing Smart Eyewear for Photophobia Management

In *Medical* and *Clinical* Cases

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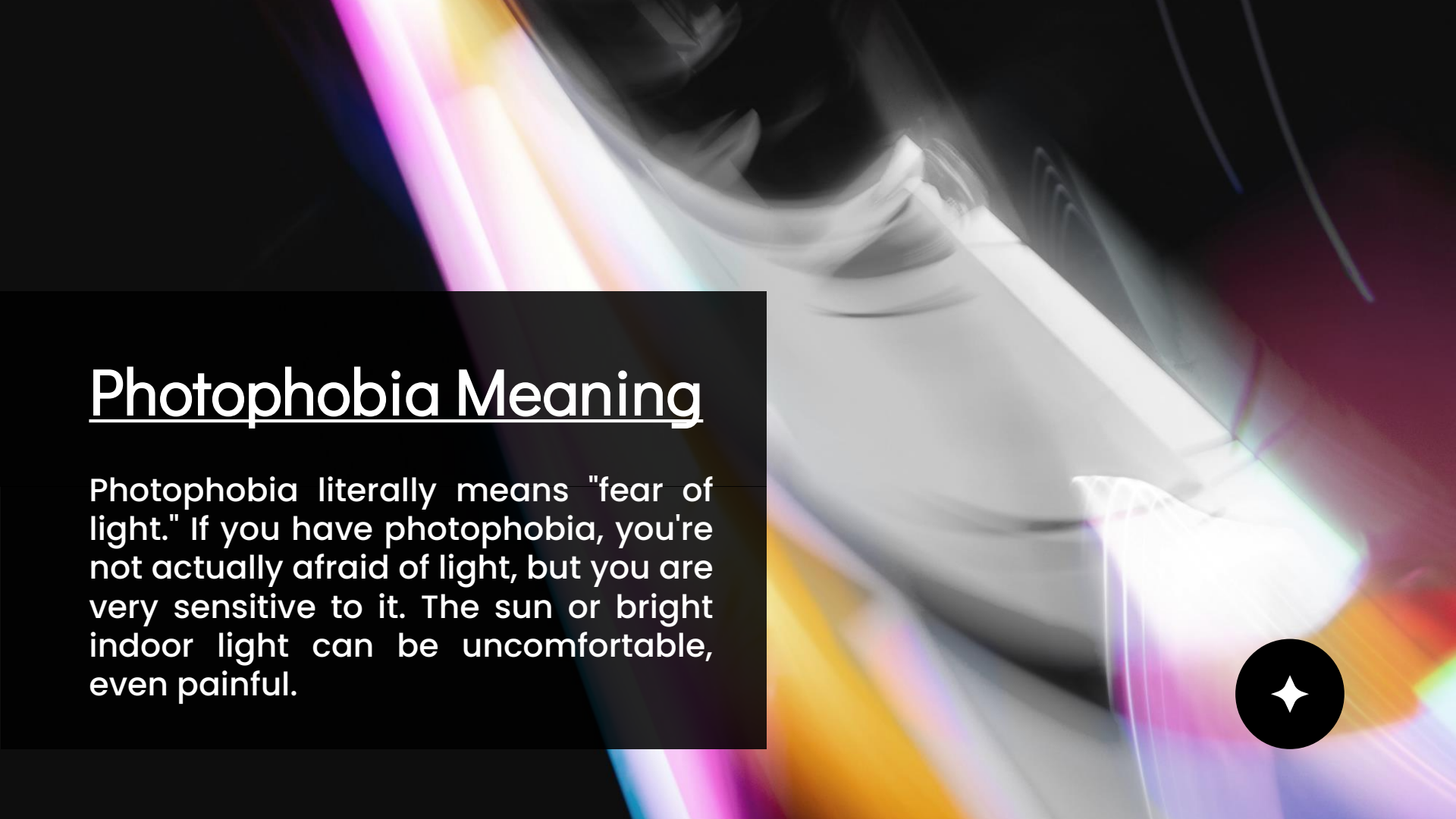


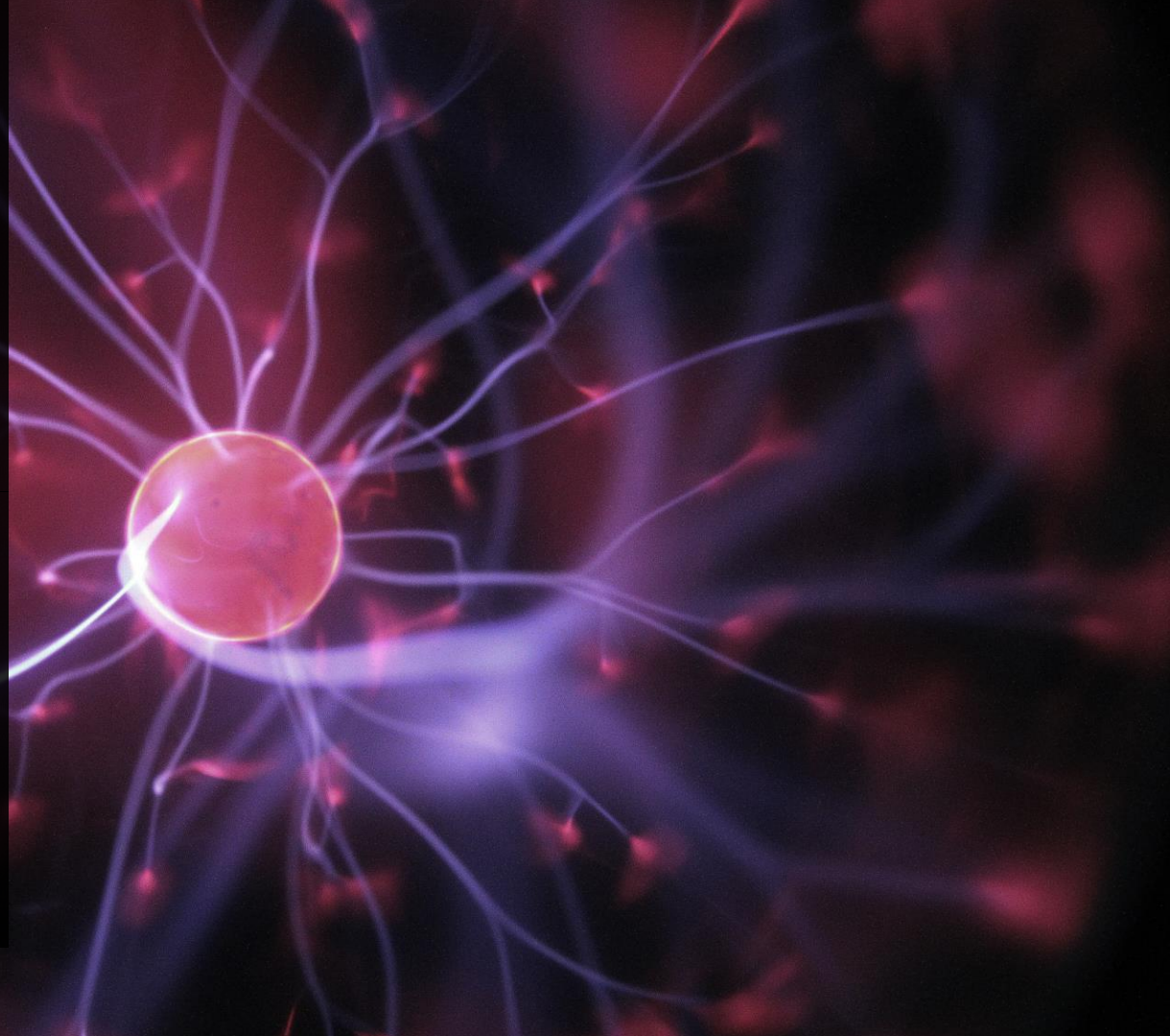
Photophobia Meaning

Photophobia literally means "fear of light." If you have photophobia, you're not actually afraid of light, but you are very sensitive to it. The sun or bright indoor light can be uncomfortable, even painful.

Medical & Clinical

01

About the demographic that the technology is destined for.



In the range between 520 and 640 nm, a positive correlation was observed between wavelength and the amount of energy required to induce photophobia. [1]
Also, people with photosensitive epilepsy receive light triggers through flashing light, between the frequency of 5 to 30 flashes per second (Hertz). [2]

People all arround the world suffer from different forms of neurological disorders, varieting from migranes to epilepsy, both with light triggers, neuro-ophthalmic and ophthalmologic diseases and psychological problems. Each of these, depending on the case, are hospitalized and monitored or live a life of constant precautions.

Neurologic [3], [4]

Migraine
Blepharospasm
Progressive supranuclear palsy
Traumatic brain injury
Meningeal irritation (meningitis, subarachnoid hemorrhage)
Thalamic Pathology (tumor, stroke, hemorrhage)
Epilepsy
Primary Headaches
Secondary Headaches
Subarachnoid hemorrhage
Lesions of the thalamus

Ophthalmic [3]

Conjunctivitis
Corneal diseases
Blepharitis
Dry eyes
Pterygia
Corneal neuropathy
Interstitial keratitis (Cogan's syndrome)
Vitritis
Uveitis
Photoreceptor dysfunction/retinal dystrophy
Albinism, achromatopsia, cone dystrophy, retinitis pigmentosa
Alström Syndrome
Sjogren-Larsson Syndrome
Retinal dystrophy
Optic neuritis
Papilledema
Chiasma
Pituitary tumor (including apoplexy)Hypophysitis
Occipital lobe
Hyperexcitability

Psychological [3], [5], [6]

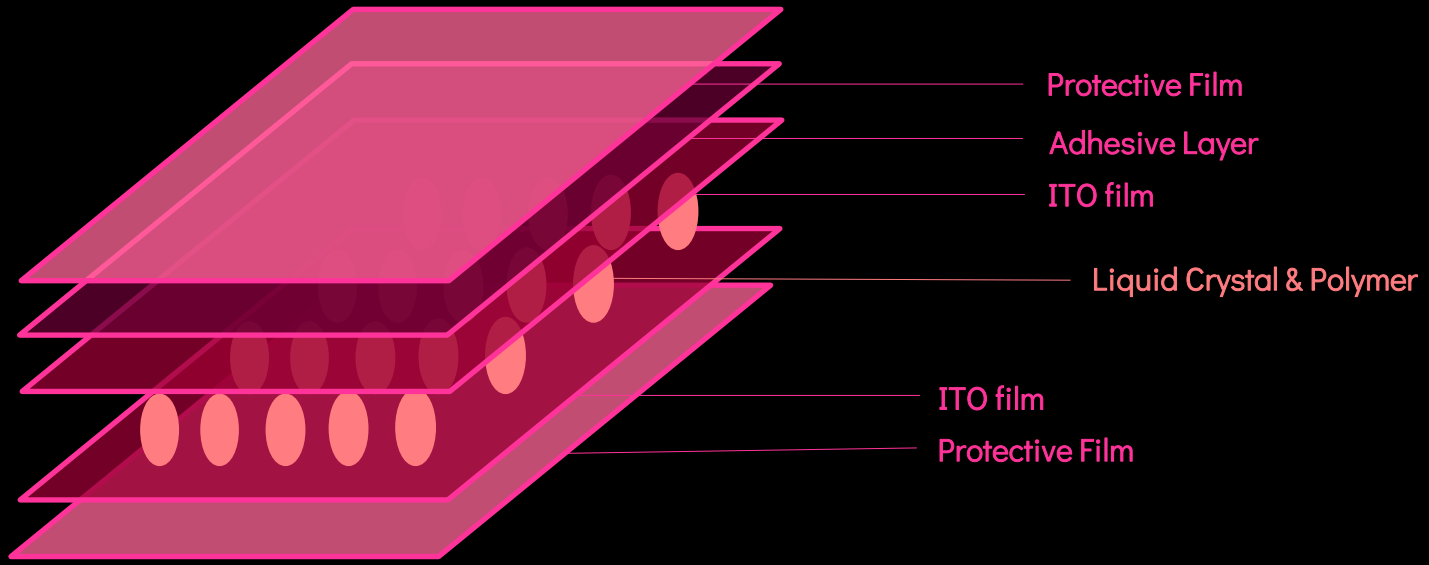
Agoraphobia
Anxiety disorder (panic disorder)
Depression
Hang-over headache
ADHD (Attention Deficit Hyperactivity Disorder)
Autism

Technology

02

What the lens does and how it works, briefly.

The Principles of Liquid Crystals and Electrochromic Filtering[7]

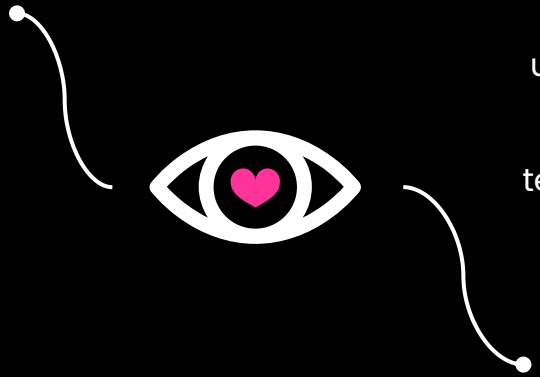


Note: The two ITO film layers are an inorganic mixture of indium(III) oxide (In_2O_3) and tin(IV) oxide (SnO_2), and the layer of Liquid Crystal and Polymer in between them consists of liquid crystal droplets and outer layer of high polymer.

Usages around *the world* with explications

Eyewear

Currently, only sunglasses with a liquid crystal film different than what I have envisioned is on the market, along with some glasses for Epilepsy, Migranes and more from Medlenses that block some of the current problem these people are facing.
What I am doing is experimental and theoretical at the moment.



Buildings

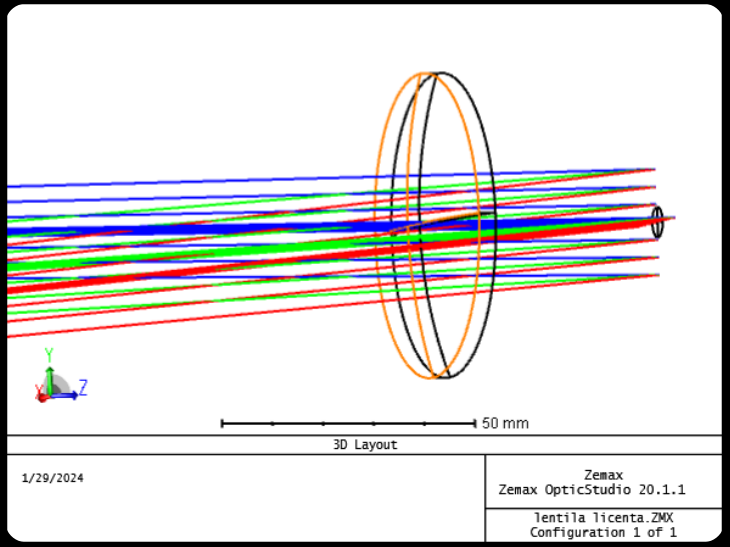
Electrochromic tech for buildings uses special materials that change color when electricity runs through them. The classical version of this technology is opaque on it's normal state and becomes transparent under tension. Usually offices use this type of technology with no other optical propriety other than blocking the light for privacy.

Other uses: liquid crystal lasers, displays, polarizers (including LCD screens to control light transmission), temperature sensors, optical devices (such as attenuators, shutters, tunable lenses), security devices (thermochromic and photochromic materials for authentication and anti-counterfeiting purposes), light modulators, photonics (tunable lasers, variable optical attenuators, and modulators for controlling the transmission of light in optical communication systems), biotechnology (liquid crystal-based biosensors for detecting biological molecules and monitoring biochemical processes) and medicine.

Experimenting

03

What I have so far
and what could / will
be improved.

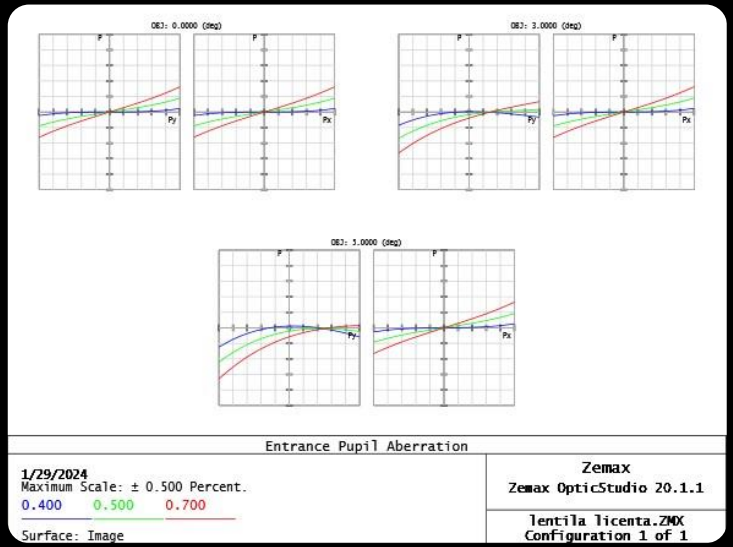


This is an olphtalmic lens made in Zemax Optic Studio for a person *with light myopia of -1.0 dpt* that corrects slightly astigmatism errors as well.

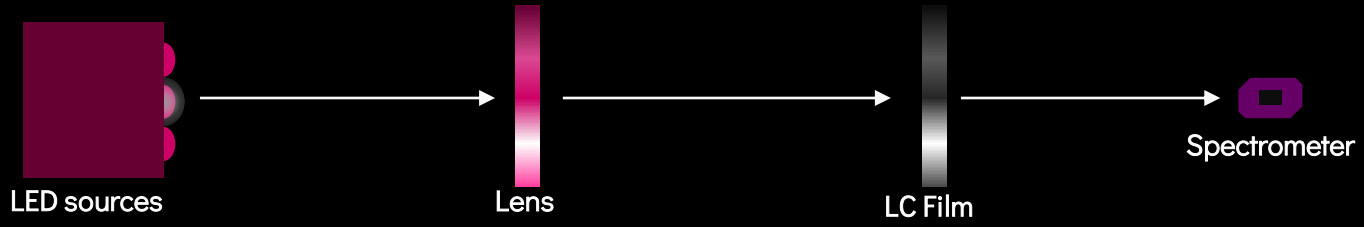
It's un uncoated, with CR-39 material, that is currently being worked on appliance of a Liquid Crystal Film, with specified parameters for blocking certain wavelengths and further, connected to a sensor .

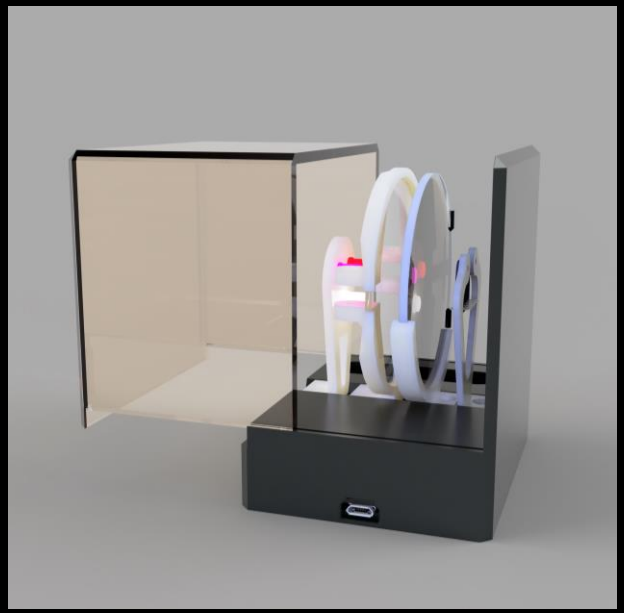
Entrance pupil aberration is defined as the difference between the real ray intercept on the stop surface and the on axis primary wavelength paraxial ray intercept as a percentage of the paraxial stop radius. [14]

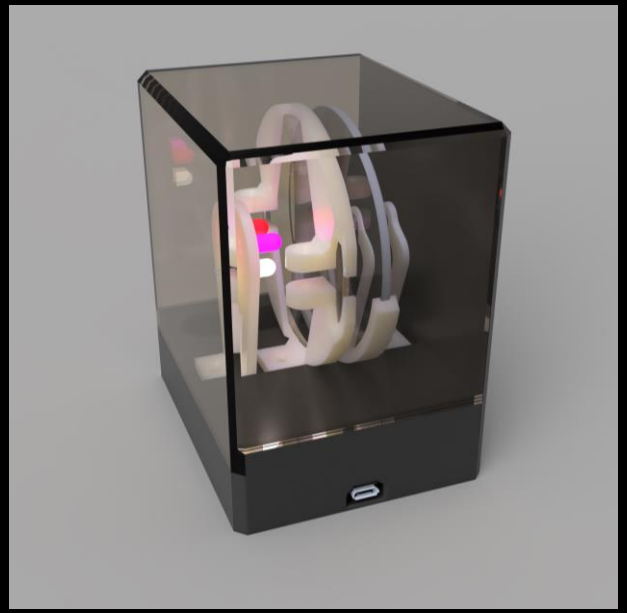
There are three types of diagrams because the fields are set in 3 different angles, 0 degres, 3 and 5.



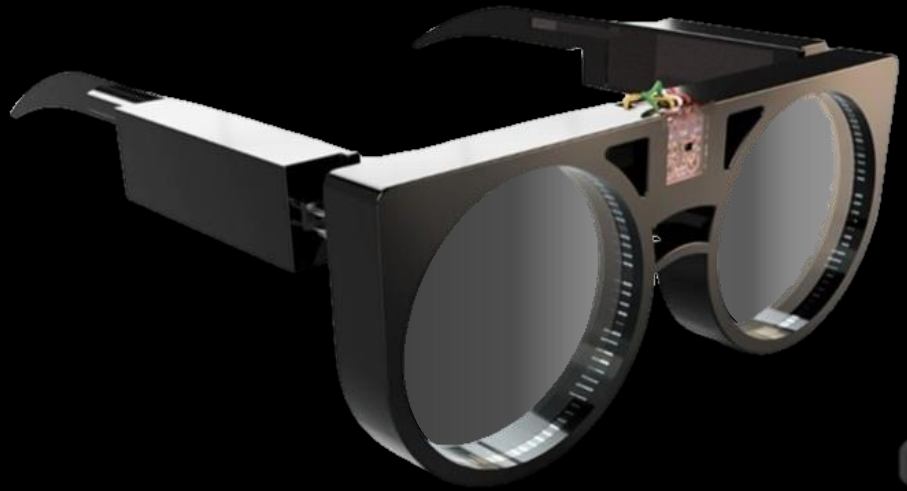
Experimental Bench







Eyewear Designing



The eyewear design is yet to be perfected into more sleek, not evident design for day to day wear, so individuals who will use this technology will be able to wear these with no issues.

04. Key takeaways

- Photophobia can be triggered either by the range of 520 and 640 nm or a frequency in flashing light of 5 to 30 flashes / second.
- People all arround the world suffer from different forms of neurological disorders, varieting from migranes to epilepsy, both with light triggers, neuro-ophthalmic and ophthalmologic diseases and psychological problems
- Liquid Crystals can be used in a variety of places, including the medical and clinical domains, but also in biophysics and lasers.
- The Electrochromic Filtering method on a CR-39 needs to be adapted in a safer and usable manner, in order to be useful.
- The design of this type of assistive eyewear has yet to receive improvements in the practical parts and aesthetically wise.

Thank you

Special thank you to prof. dr. Ciprian Ion Rizescu (University of Science and Technology Politechnica of Bucharest) and asoc. prof. dr. Dana Craiu (Carol Davila University of Medicine and Pharmacy) for the help in the making of the project.

References

1. A. J. Wenzel, K. Fuld, J. M. Stringham, and J. Curran-Celentano, “Macular pigment optical density and photophobia light threshold,” Vision Res., vol. 46, no. 28, pp. 4615–4622, Dec. 2006, doi: 10.1016/j.visres.2006.09.019.

2. ‘Photosensitivity and Seizures’, accessed on 27/01/2024, available: https://www.epilepsy.com/what-is-epilepsy/seizure-triggers/photosensitivity

3. K. B. Digre and K. C. Brennan, “Shedding Light on Photophobia,” J. Neuroophthalmol., vol. 32, no. 1, pp. 68–81, Mar. 2012, doi: 10.1097/WNO.0b013e3182474548

4. Wu Y, Hallett M. Photophobia in neurologic disorders. Transl Neurodegener. 2017 Sep 20;6:26. doi: 10.1186/s40035-017-0095-3. PMID: 28932391; PMCID: PMC5606068.

5. ‘ADHD Light Sensitivity: The Link with Hypersensitivity & Sensory Processing’, accessed on 27/01/2024, available: https://www.theraspecs.com/blog/adhd-light-sensitivity-hypersensitivity-sensory-processing/

6. ‘Sensory Issues’, accessed on 27/01/2024, available: https://www.autismspeaks.org/sensory-issues#:~:text=Many%20autistic%20people%20experience%20hypersensitivity,people%20can%20easily%20tune%20out.

7. “Smart Glass Opens a Window to New Applications’, accessed on 27/01/2024, available: https://www.radiantvisionsystems.com/blog/smart-glass-opens-window-new-applications

8. “Photosensitive Epilepsy Glasses,” Medlenses. Accessed: Dec. 06, 2023. [Online]. Available: https://medlenses.com/collections/epilepsy-glasses

9. “CREATING HEALTHIER, MORE SUSTAINABLE BUILDINGS?”, accessed on 20/01/2024, available: https://www.merckgroup.com/en/research/science-space/envisioning-tomorrow/smarter-connected world/liquidcrystalwindows.html

10. “LCC1623 - Liquid Crystal Shutter / Variable Attenuator, Ø20 mm, 1050 - 1700 nm, 8-32 Taps”, accessed: 29/01/2024, available: https://www.thorlabs.com/thorproduct.cfm?partnumber=LCC1623#ad-image-0

11. “EXULUS-HD3 - Spatial Light Modulator, 1920 x 1200, 650 - 1100 nm, Universal 8-32 / M4 Taps”, accessed: 29/01/2024, available: https://www.thorlabs.com/thorproduct.cfm?partnumber=EXULUS-HD3

12. “LCC25 - Liquid Crystal Controller, 0-25 VAC, Square Wave, 50% Duty Cycle”, accessed: 29/01/2024, available: https://www.thorlabs.com/thorproduct.cfm?partnumber=LCC25

13. “NEL04A/M - High-Power Noise Eater / EO Modulator for 1050 - 1620 nm, M4 Taps”, accessed: 29/01/2024, available: https://www.thorlabs.com/thorproduct.cfm?partnumber=NEL04A/M

14. “User Manual” Zemax Optic Studio 20.1, updated in January 2020

15. “Nothing can dim the light which shines from within.”, accessed: 29/01/2024, available: https://www.goodreads.com/quotes/67751-nothing-can-dim-the-light-which-shines-from-within