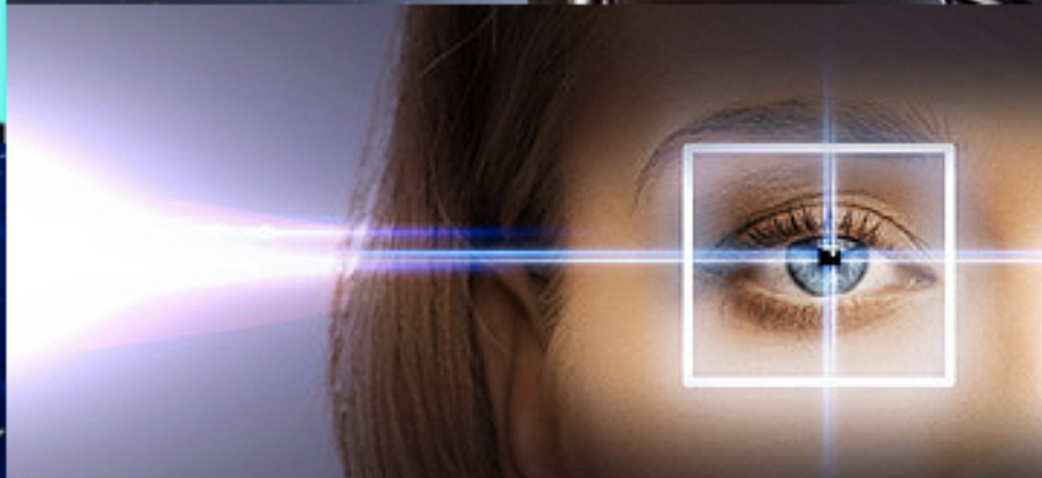
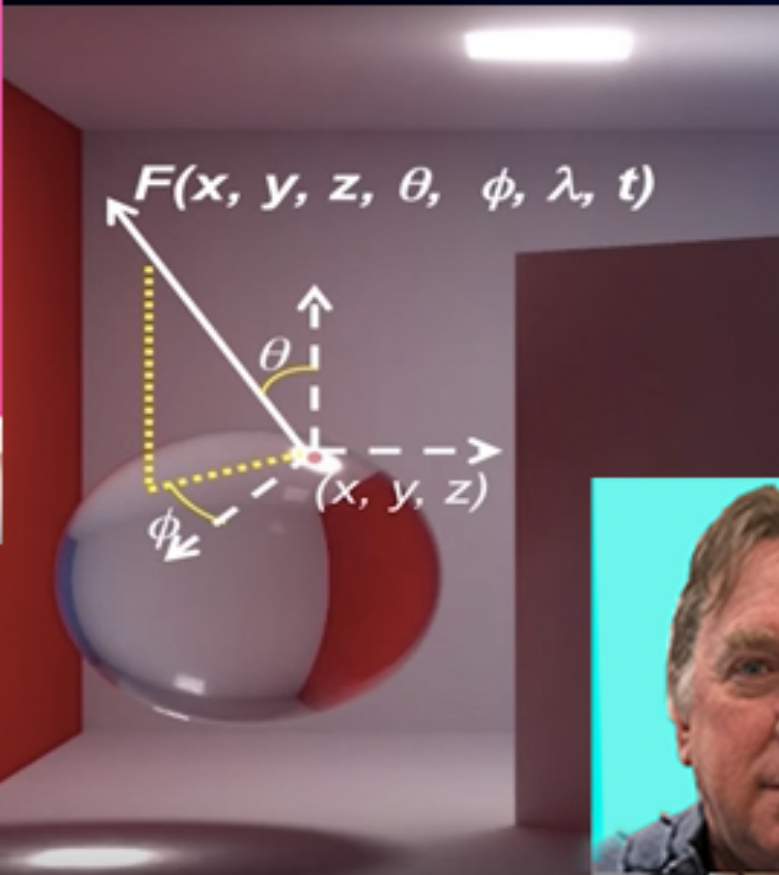


IESSF Emerging Technologies in Lighting

The Hottest, Smartest, & (Mostly) Non-IoT



Jan.19 2017

Dynamic Optics for Lighting

Tom Killick

VP Business Dev, LensVector

What it is

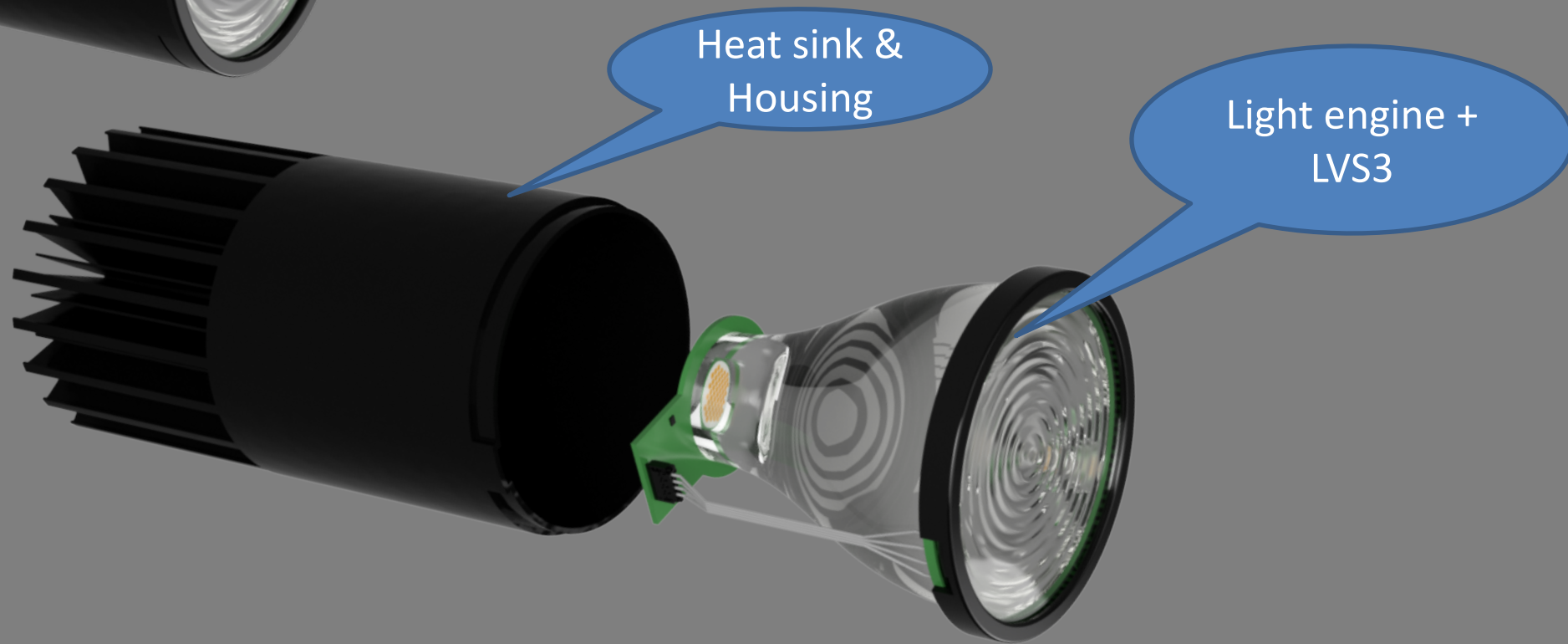
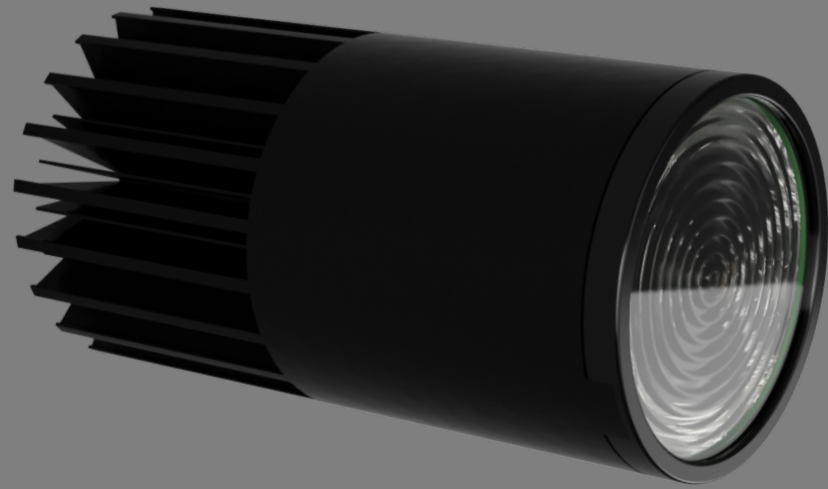


Dynamic Control of **beam shape** in the palm of your hand

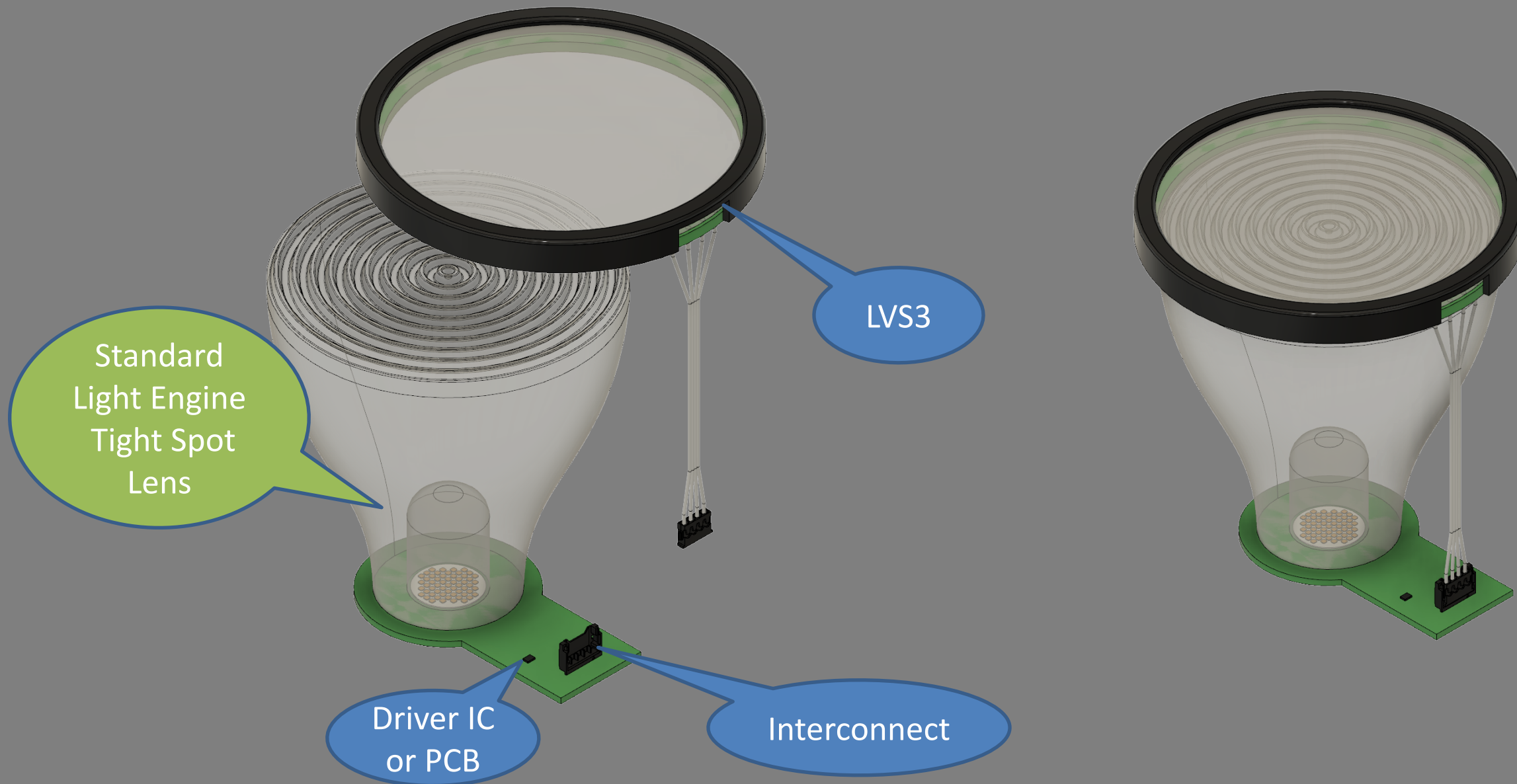
Without Moving Parts

<https://vimeo.com/199243790>

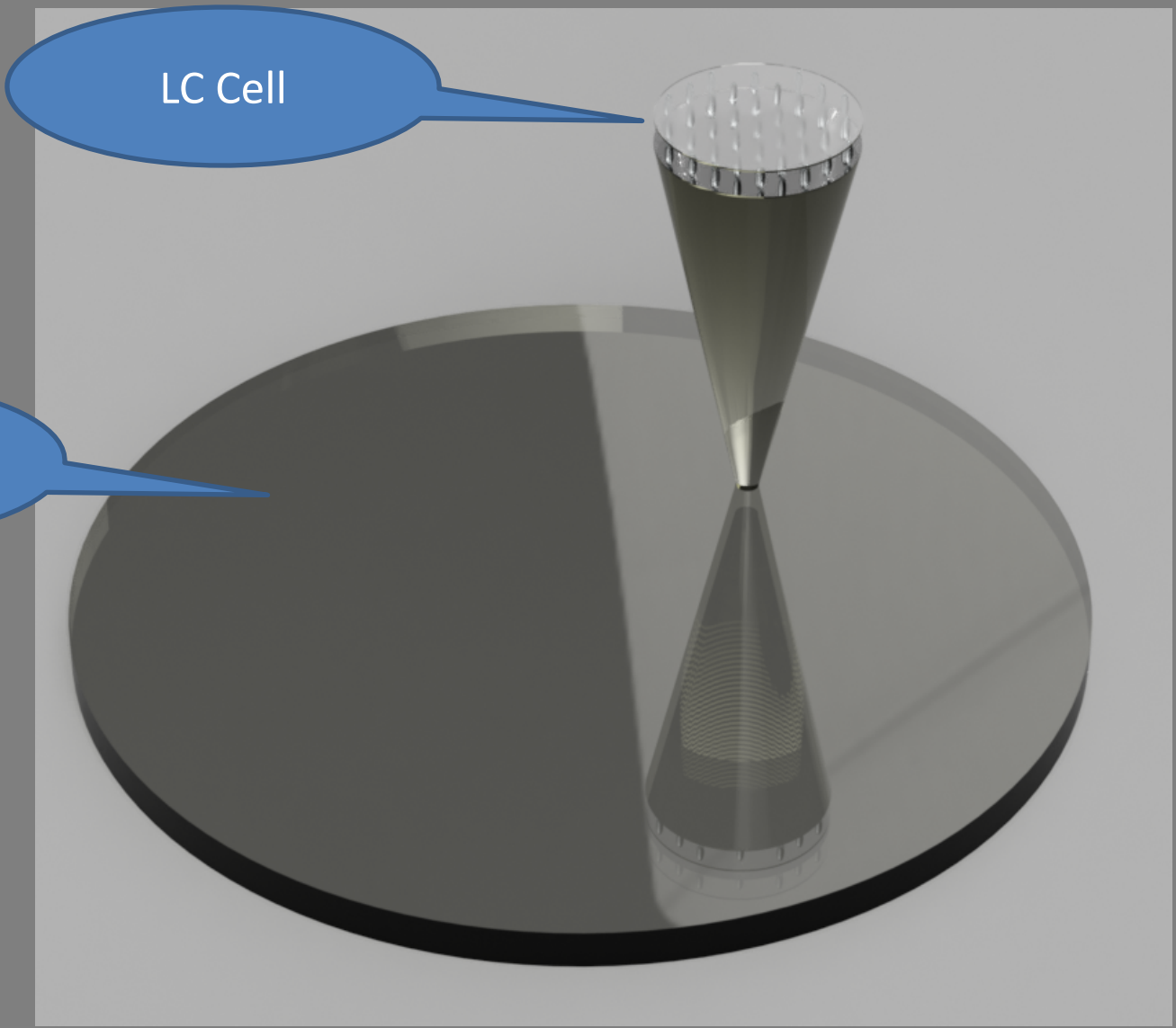
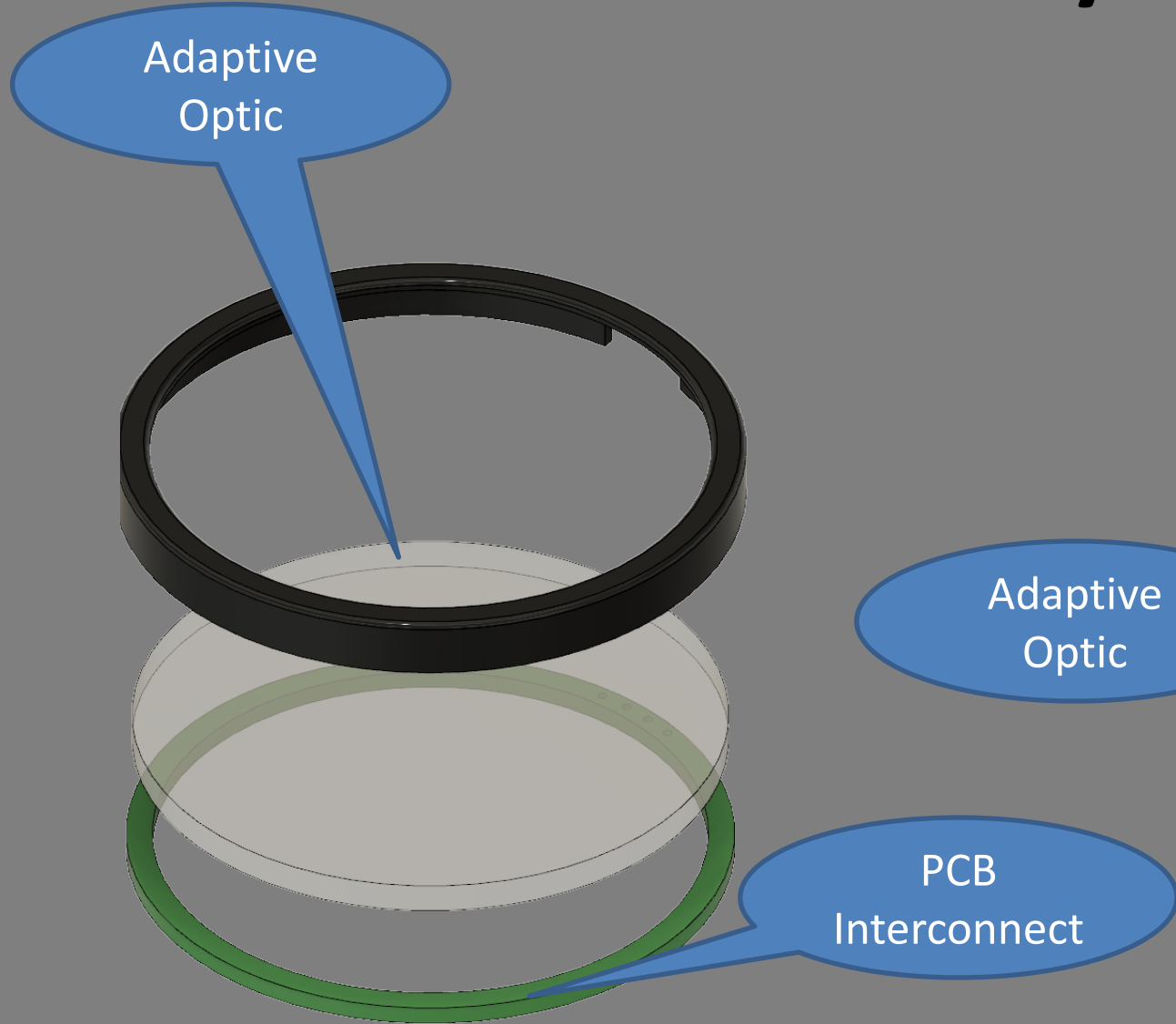
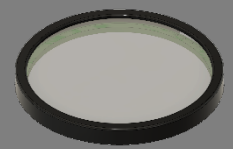
Dissection



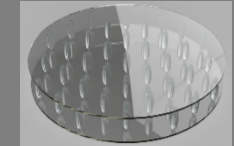
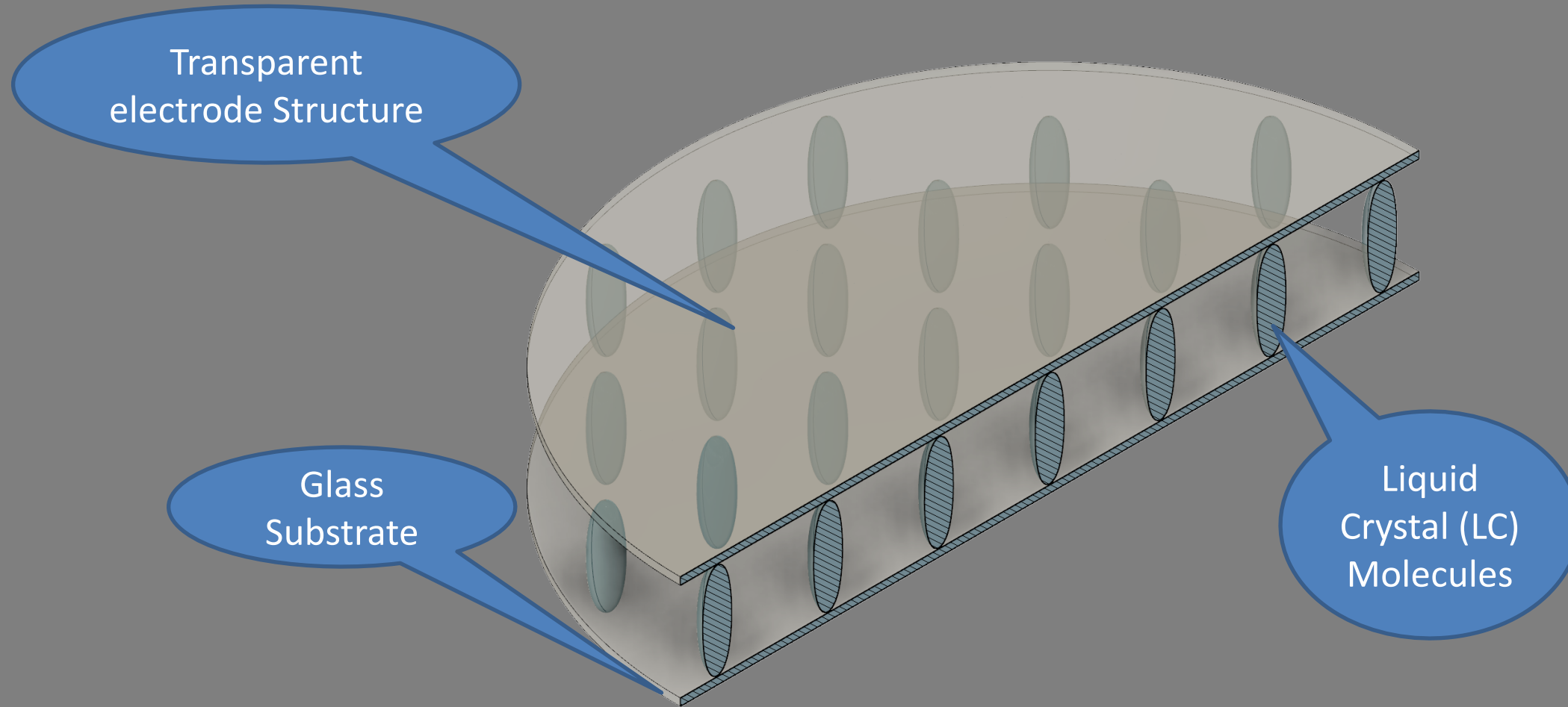
Adding Adaptive Optics



Lens Array- “metasurface”

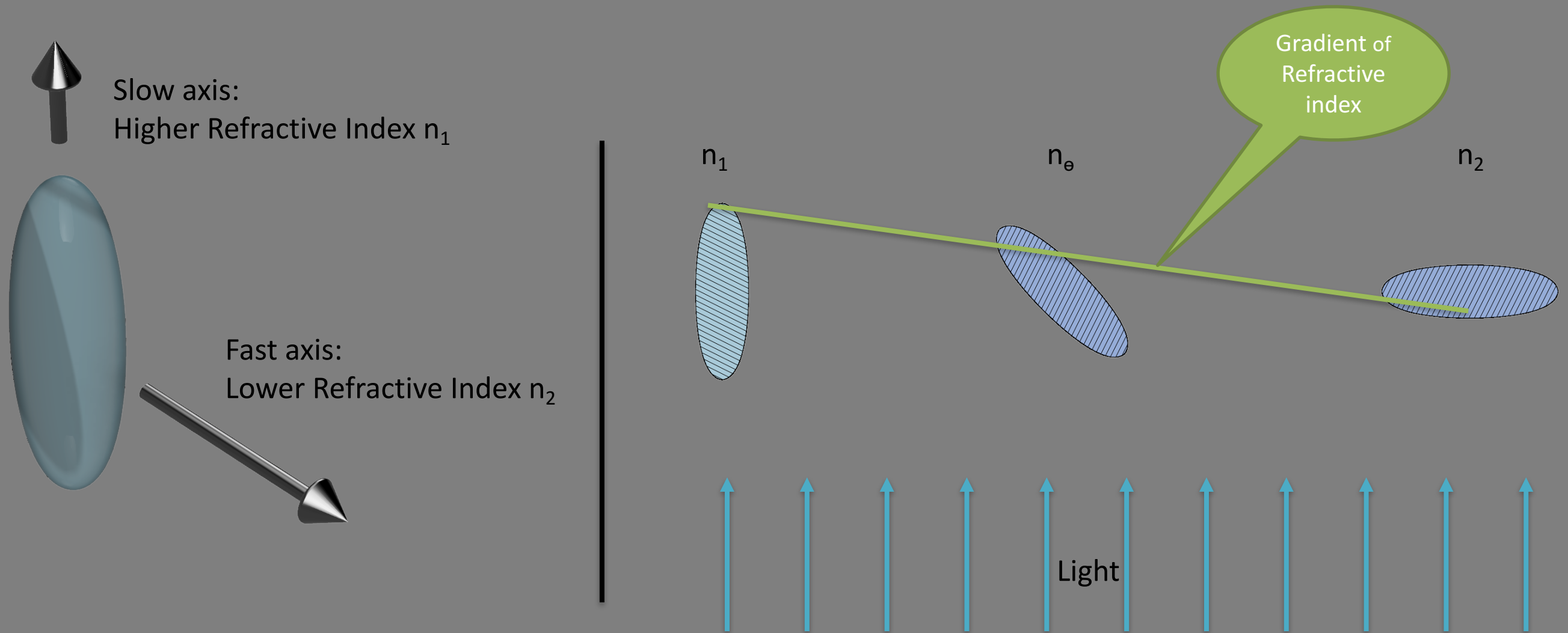


Technology : Micro LC Lens

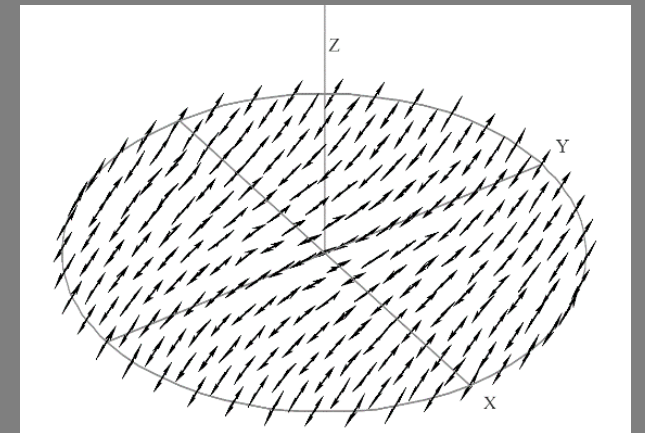
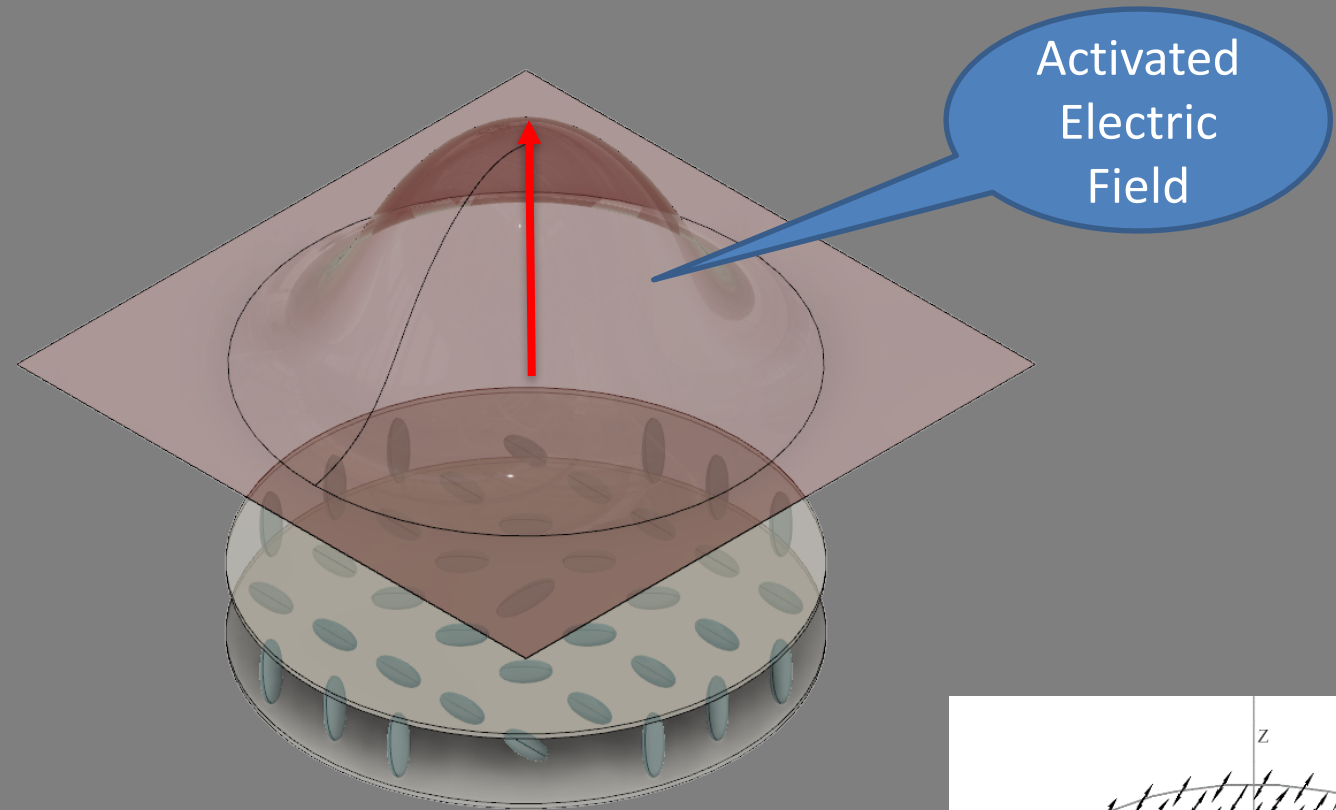
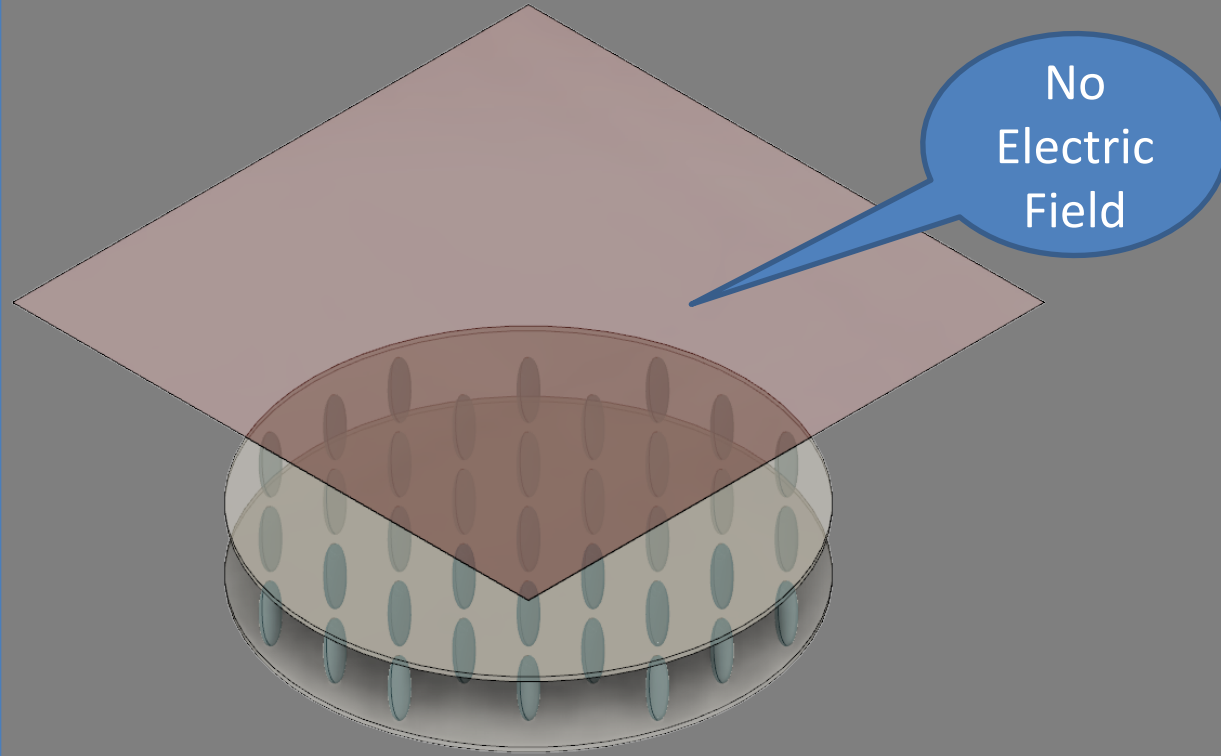


Light Propagation in LC Molecules

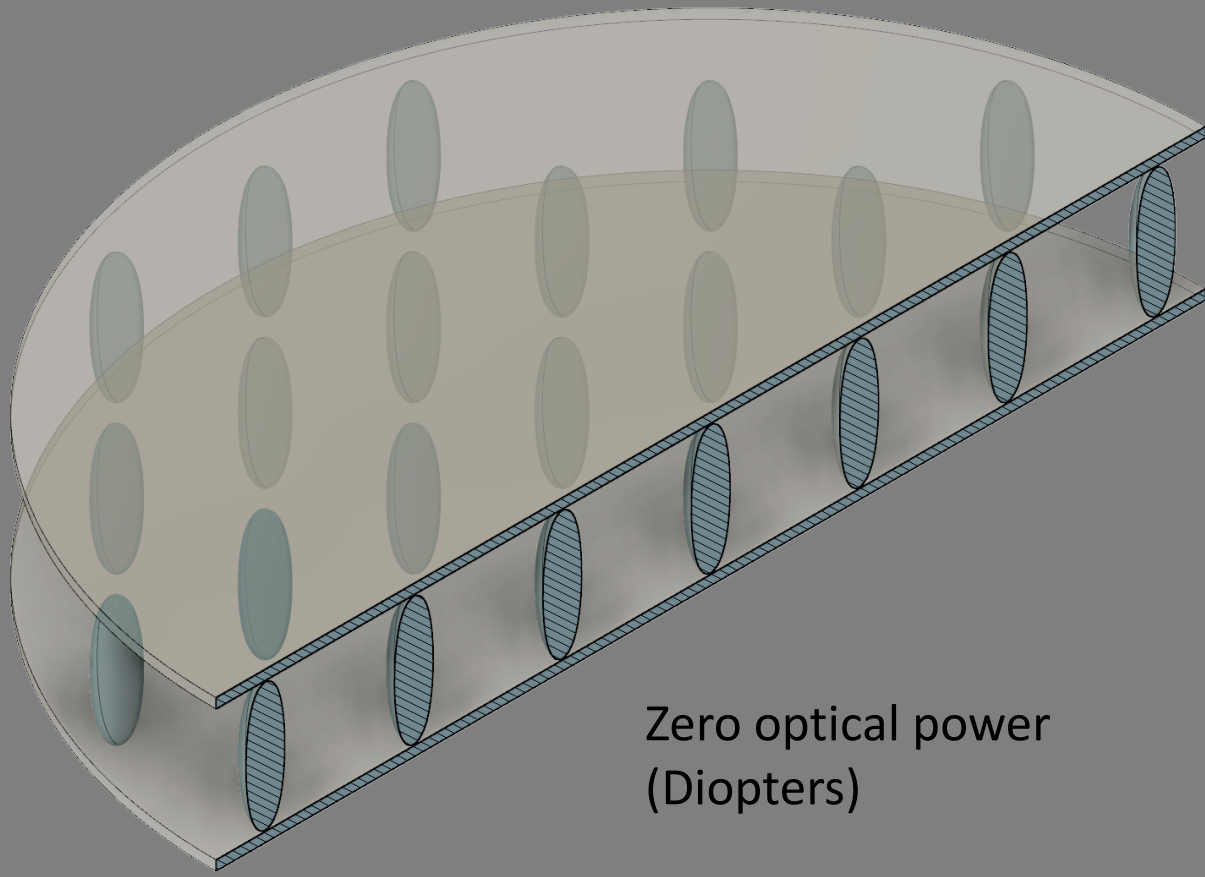
Treat the two resolved polarizations separately



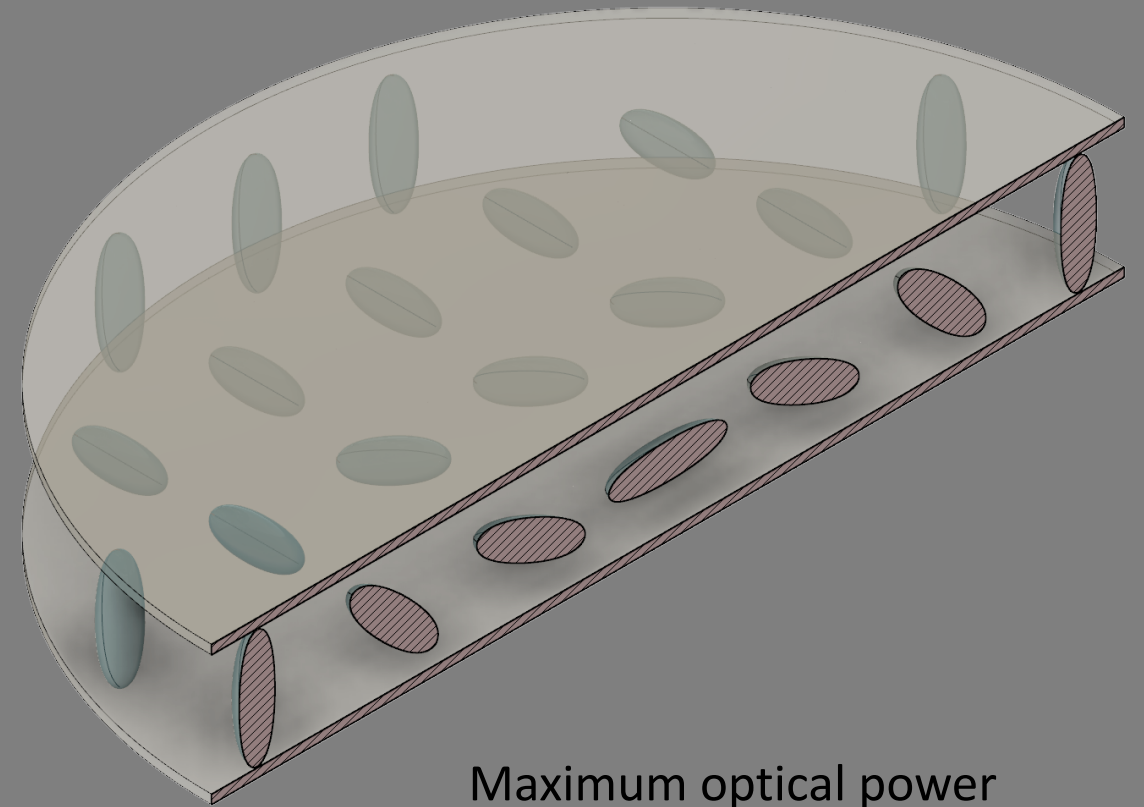
Electric Field Controls Orientation



Molecular Action



Zero optical power
(Diopters)



Maximum optical power
(Diopters)

Recap: How does it work?

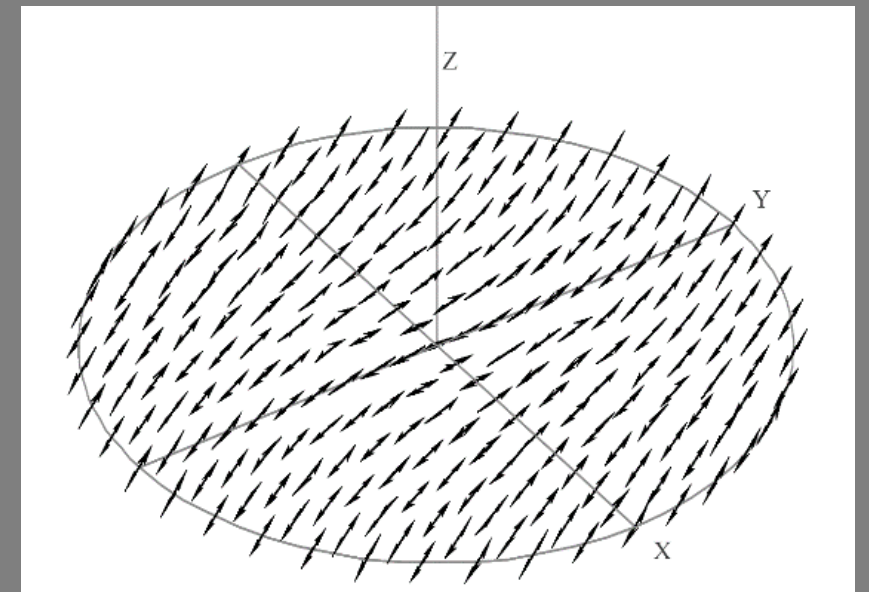
- Solid-state control of light using liquid crystals
 - Molecular orientation changes are obtained by changing electric field profiles hence inducing a corresponding gradient of refractive index.
- Properties of Liquid Crystals
 - Birefringence
 - Aligned nematic LC's are uniaxially birefringent.
No – Ne can be >0.2
(calcite is 0.17, quartz is 0.01)
 - Self-organizing
 - LC molecules tend to align with each other.
 - Rotated by E-field
 - Applying an E-field torques the molecules, rotating the birefringent axis.

Recap: Liquid Crystal Cell

- Alignment layers orient the molecules initially
- Applying an E-field rotates them
- n effective is tuned

A Gradient E-field

- Stronger at the edges than at the center, the effective index is lower at the edge than in the center, creating a positive GRIN lens



Gradient Birefringent Lens

- Optical power is proportional to OPD variation:
 - LC cell thickness
 - LC birefringence
- And inversely proportional to (clear aperture)²
- Practical limits to LC cell thickness are imposed by response time and optical parameters.

Practical Considerations

- Optical Transmission 78 to 90 %
 - Losses primarily due to scattering, absorption less than 5%
- Power consumption single digit mW
- Expected lifetime 10,000's hours
 - Simpler device than LCD TV same materials
- Competitively priced

The Future

- Complete control of beam shape
 - Micro lens addressing
- Beam Steering
- BATWINGS!???

Thank You!



LensVector

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