A Physicist's First Year in Industry

Taylor Byrum

2/27/2017

My path to Texas Instruments

Oklahoma Baptist University

2006

University of Arkansas

2008

2010

Inprentus Precision Optics

2015

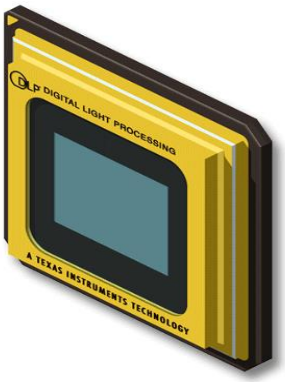
Texas Instruments

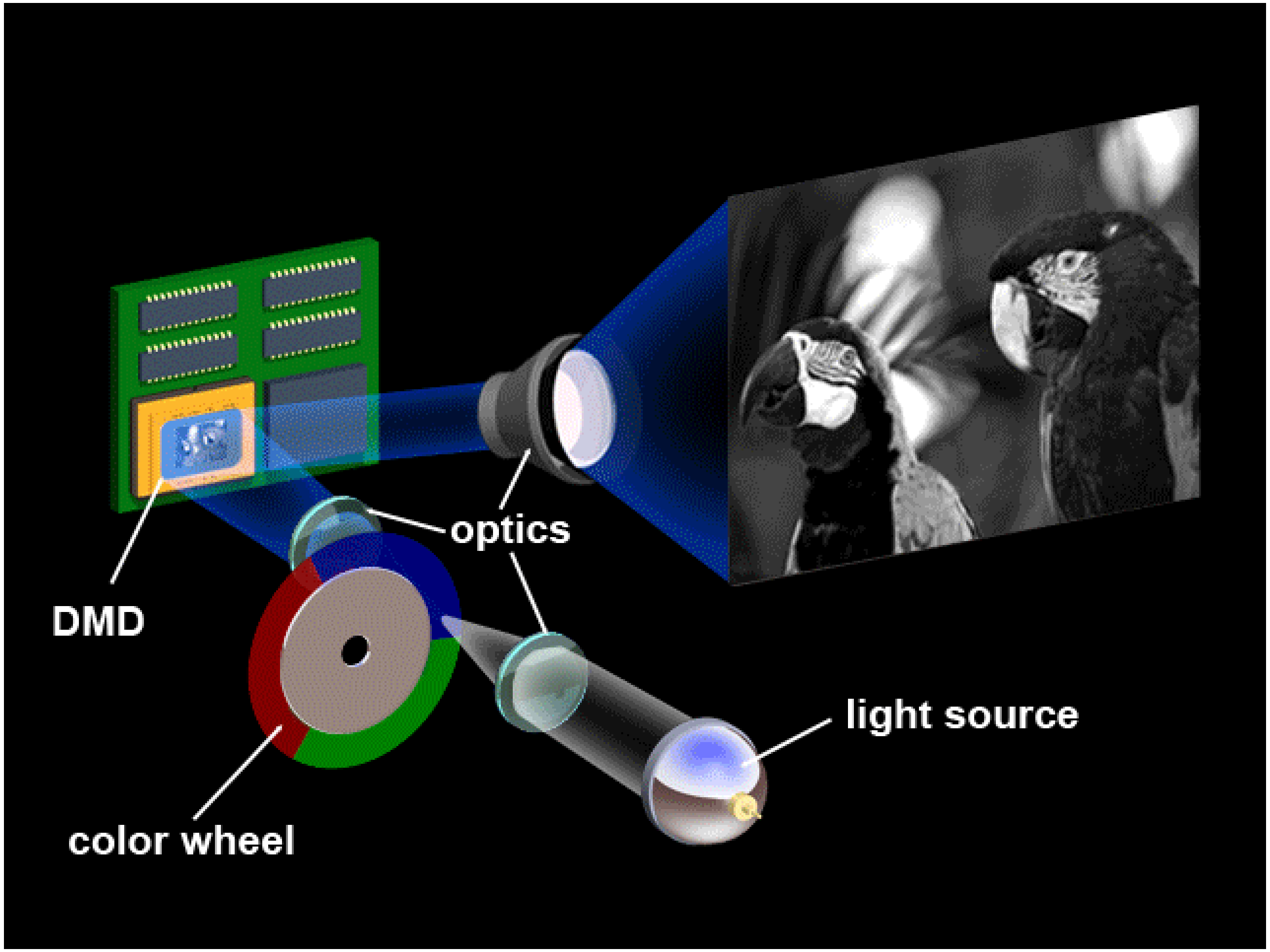
2016

http://physics.illinois.edu/careers-seminar/UIUC_Physics_Career_Seminar_Byrum.pdf

DLP® Technology

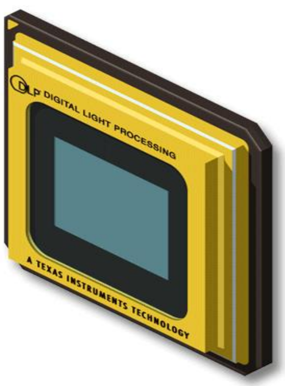
Digital Micromirror Device (DMD)

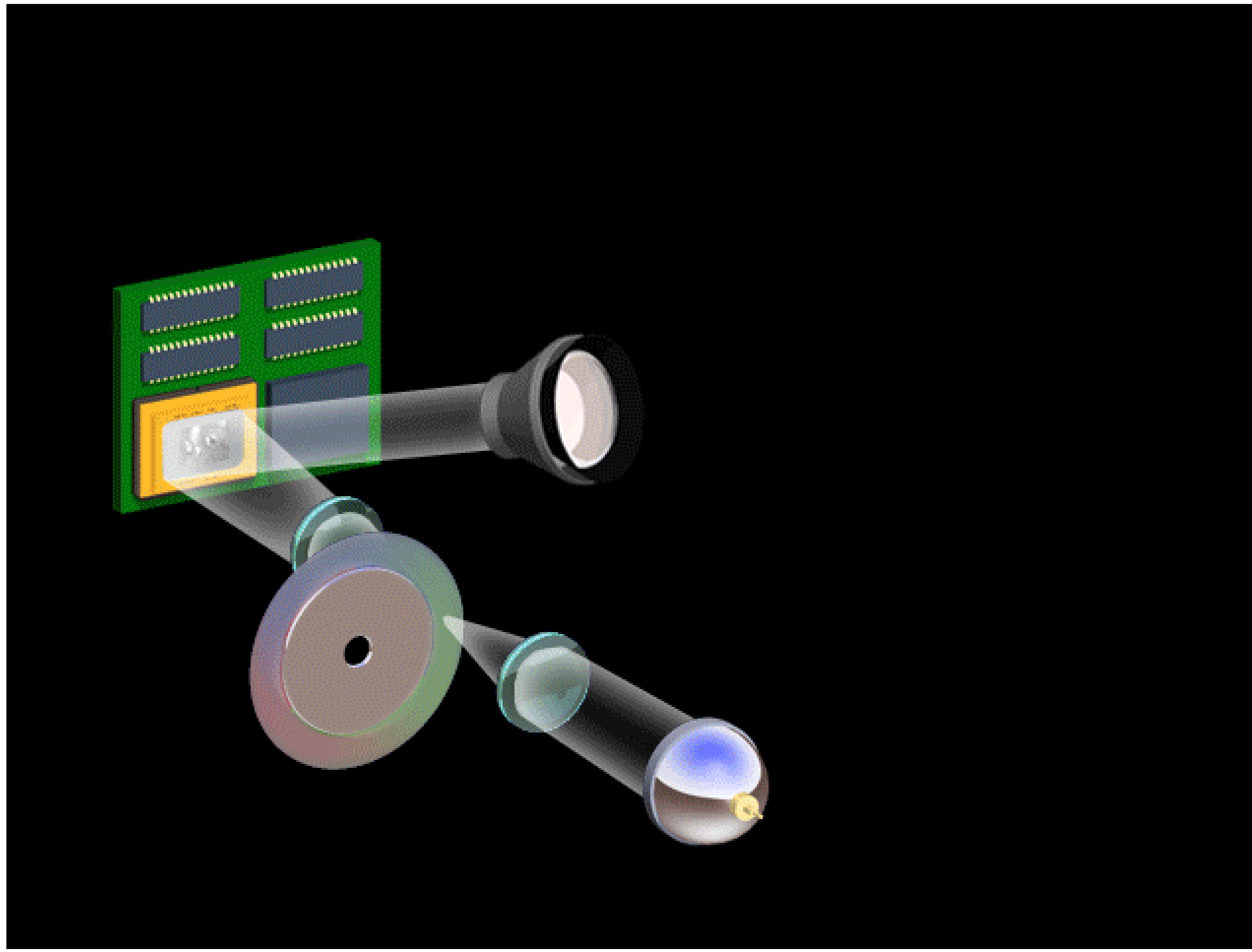




DLP Technology

Digital Micromirror Device (DMD)

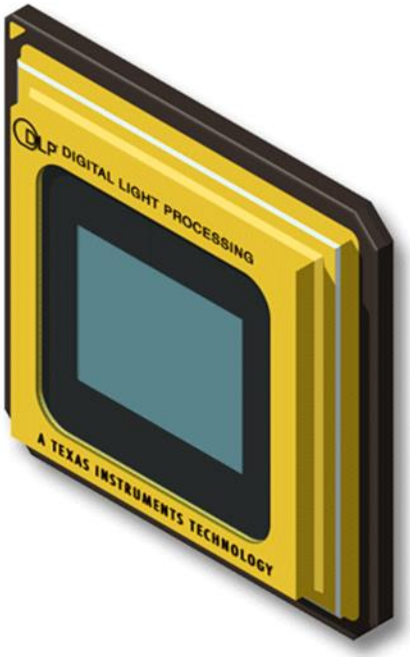




Digital Micromirror Device (DMD)

MEMS device
Invented by solid state physicist Larry Hornbeck

Mechanical motion
Makes discrete contacts or landings



Number of mirrors
150,000 to >4,000,000

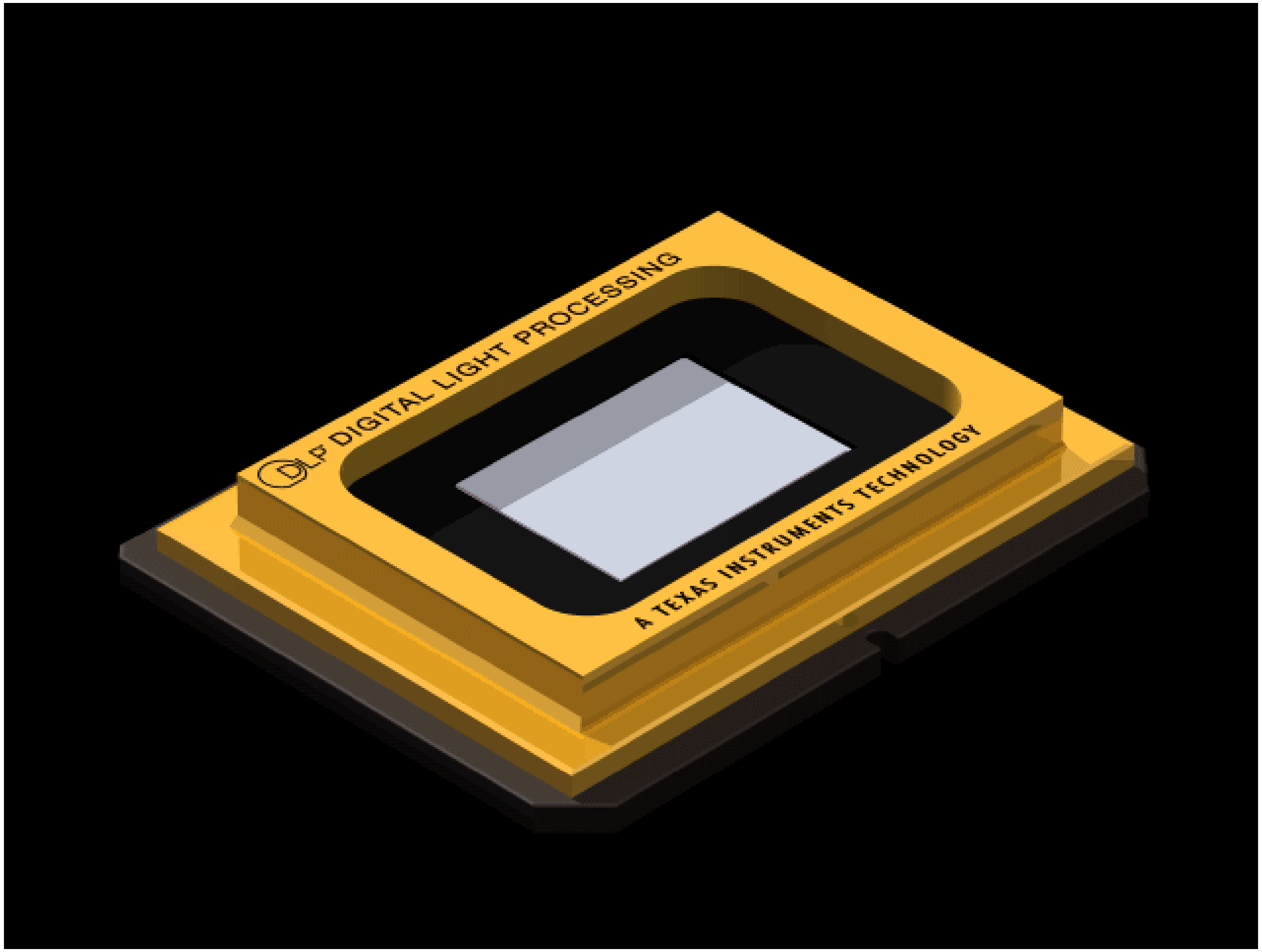
Address voltage
3.3-volt CMOS technology

Mechanical elements
Aluminum

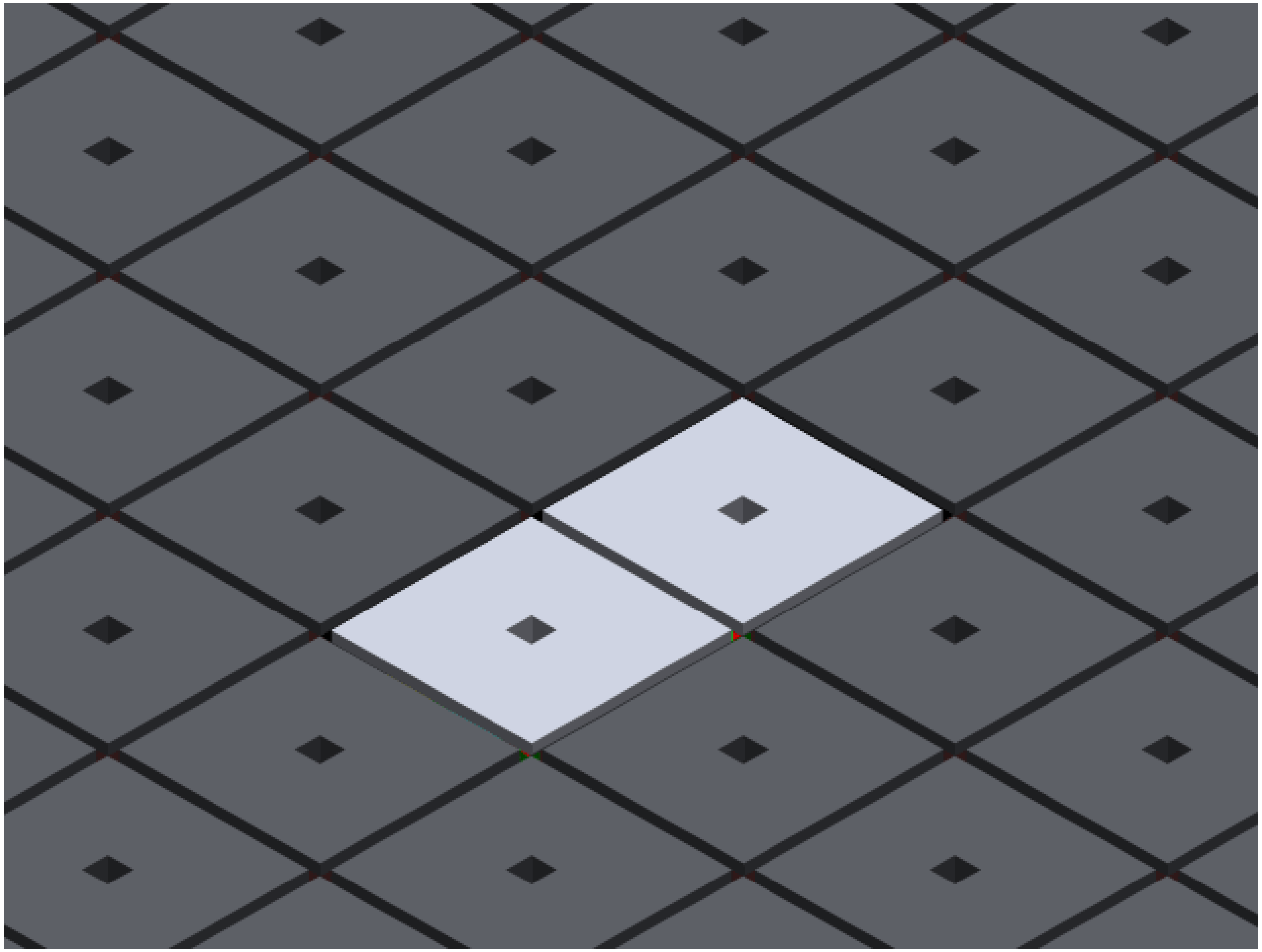
Lifetime
up to 100,000 hrs

Process
Low temperature, sputter deposition, plasma etch (standard SC processes)

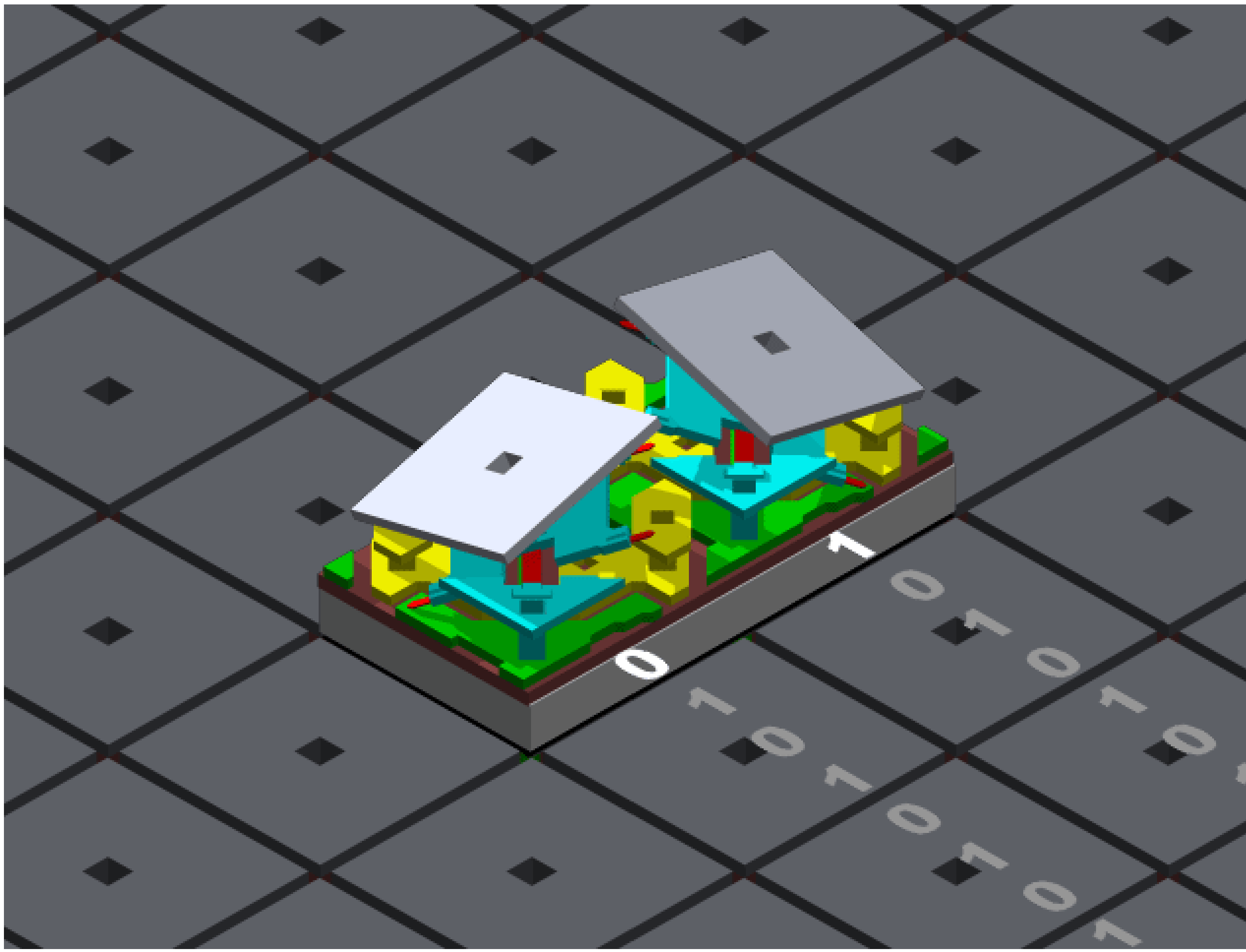
How DLP technology works



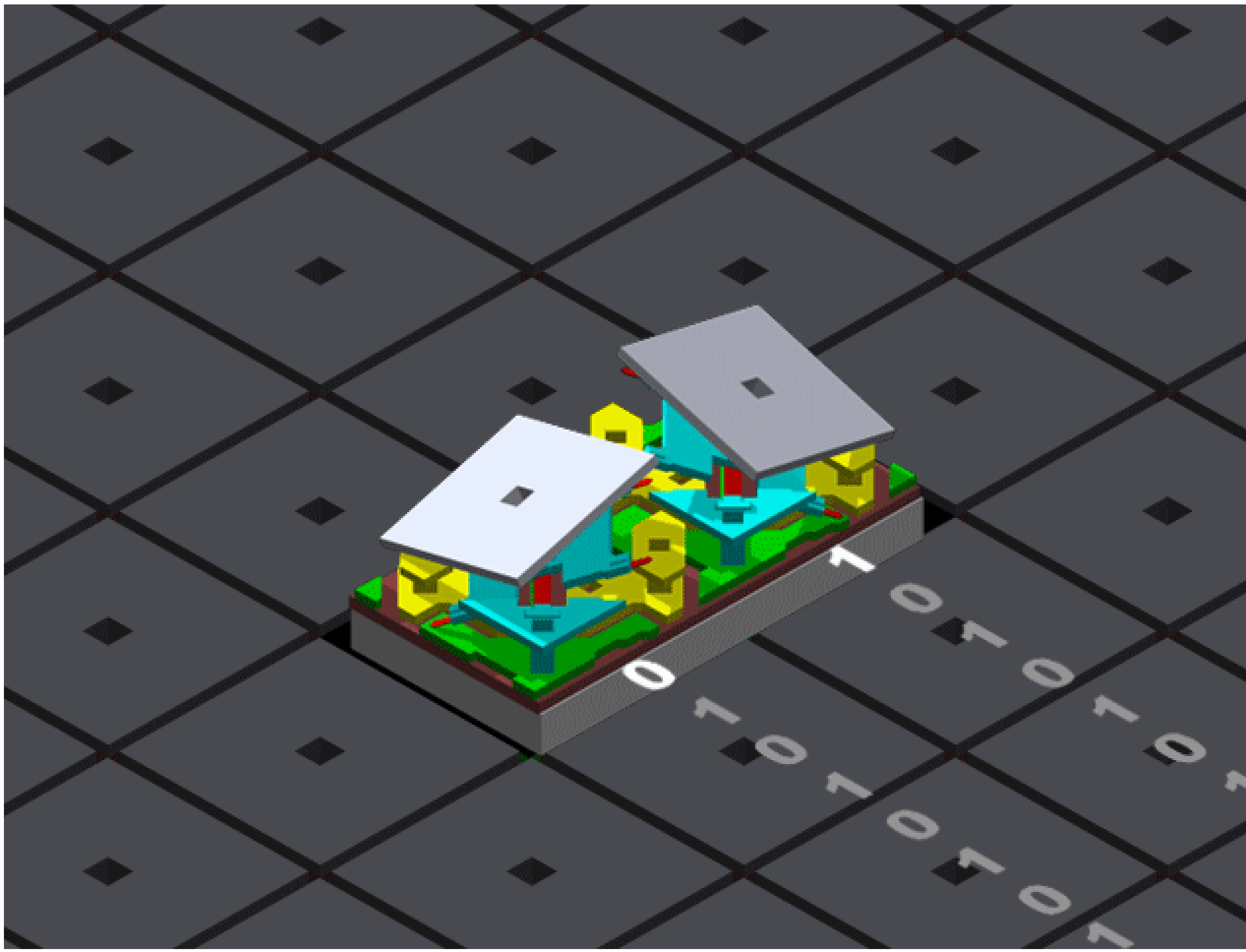
How DLP technology works



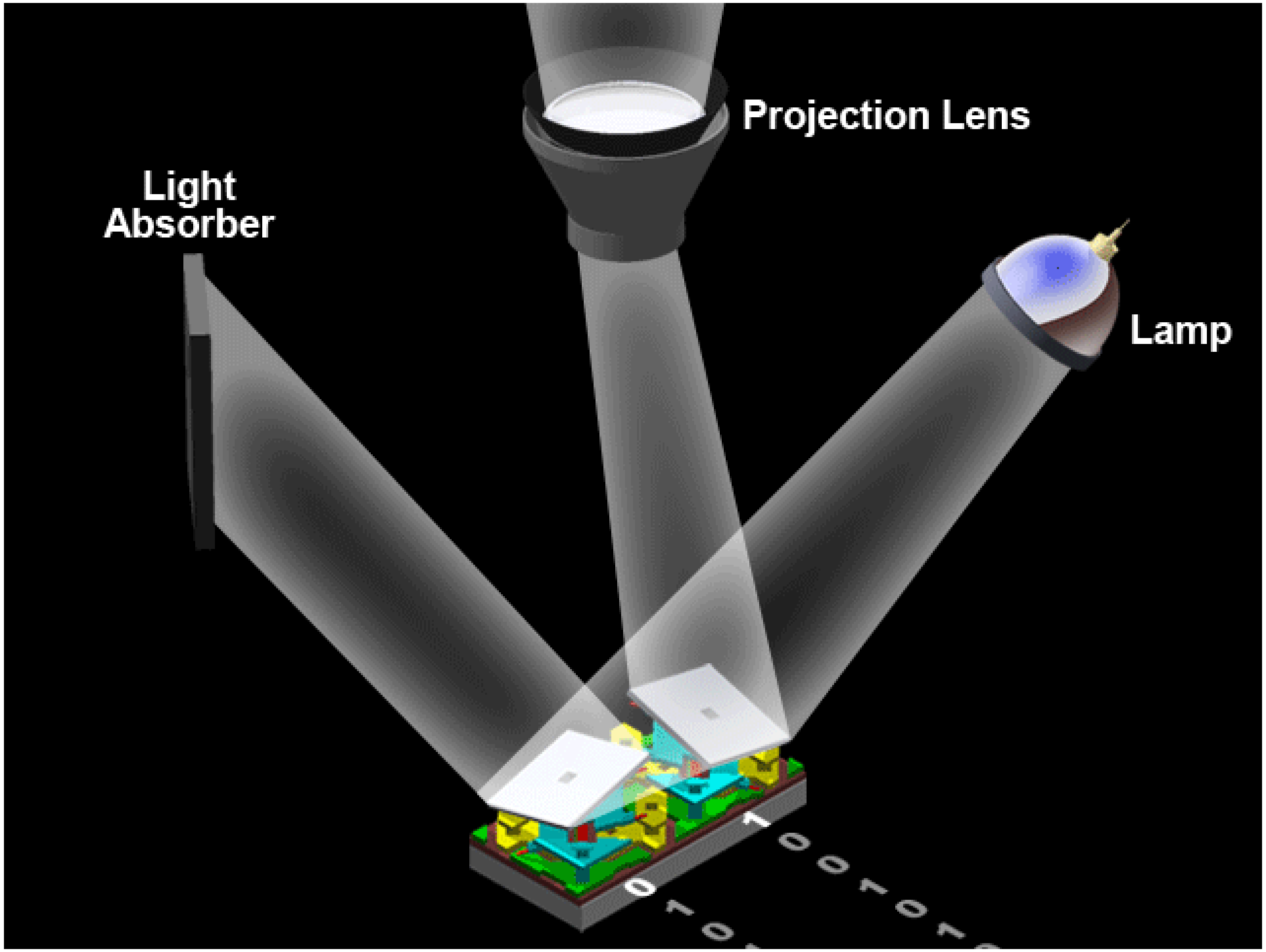
How DLP technology works



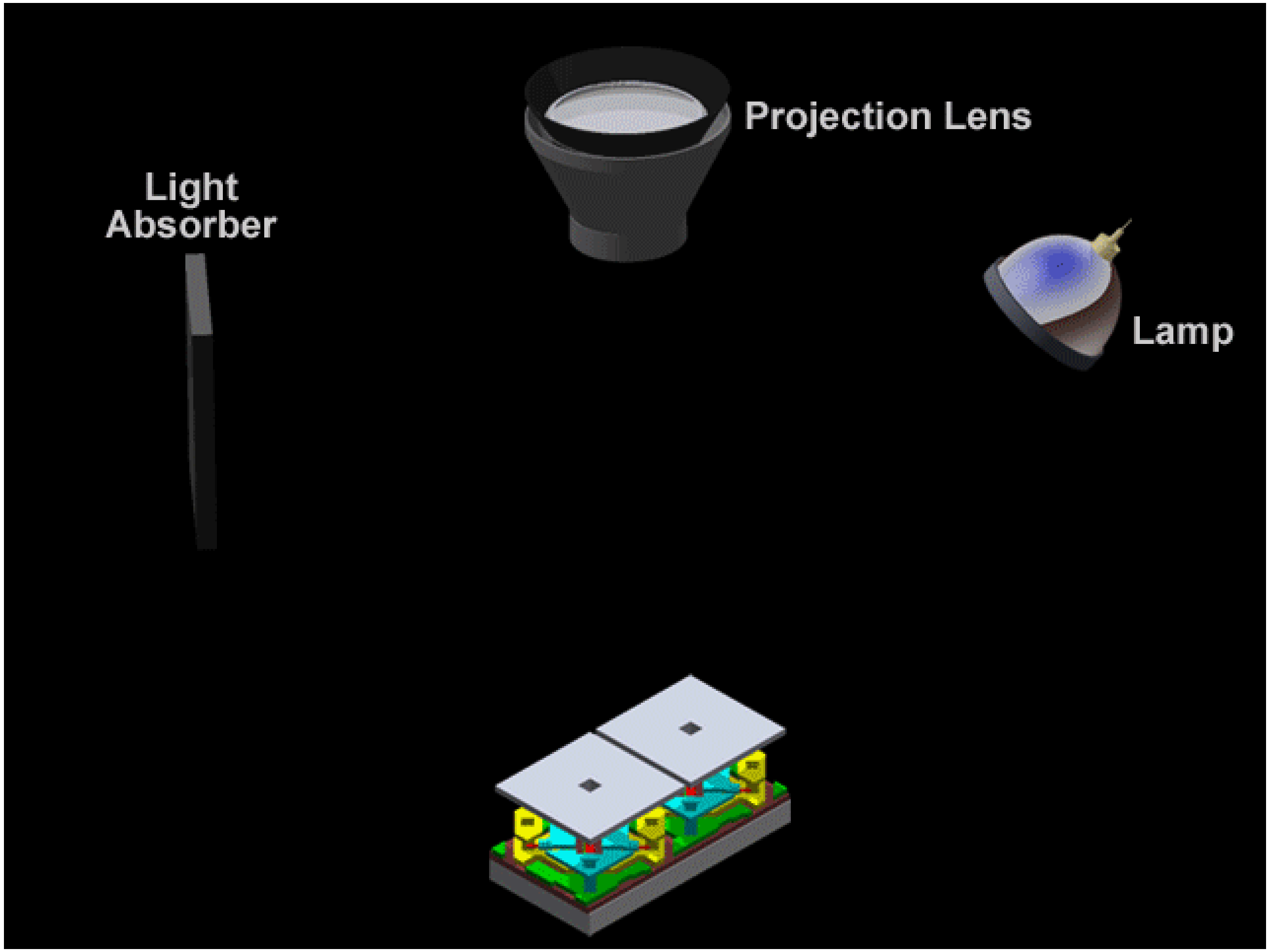
How DLP technology works



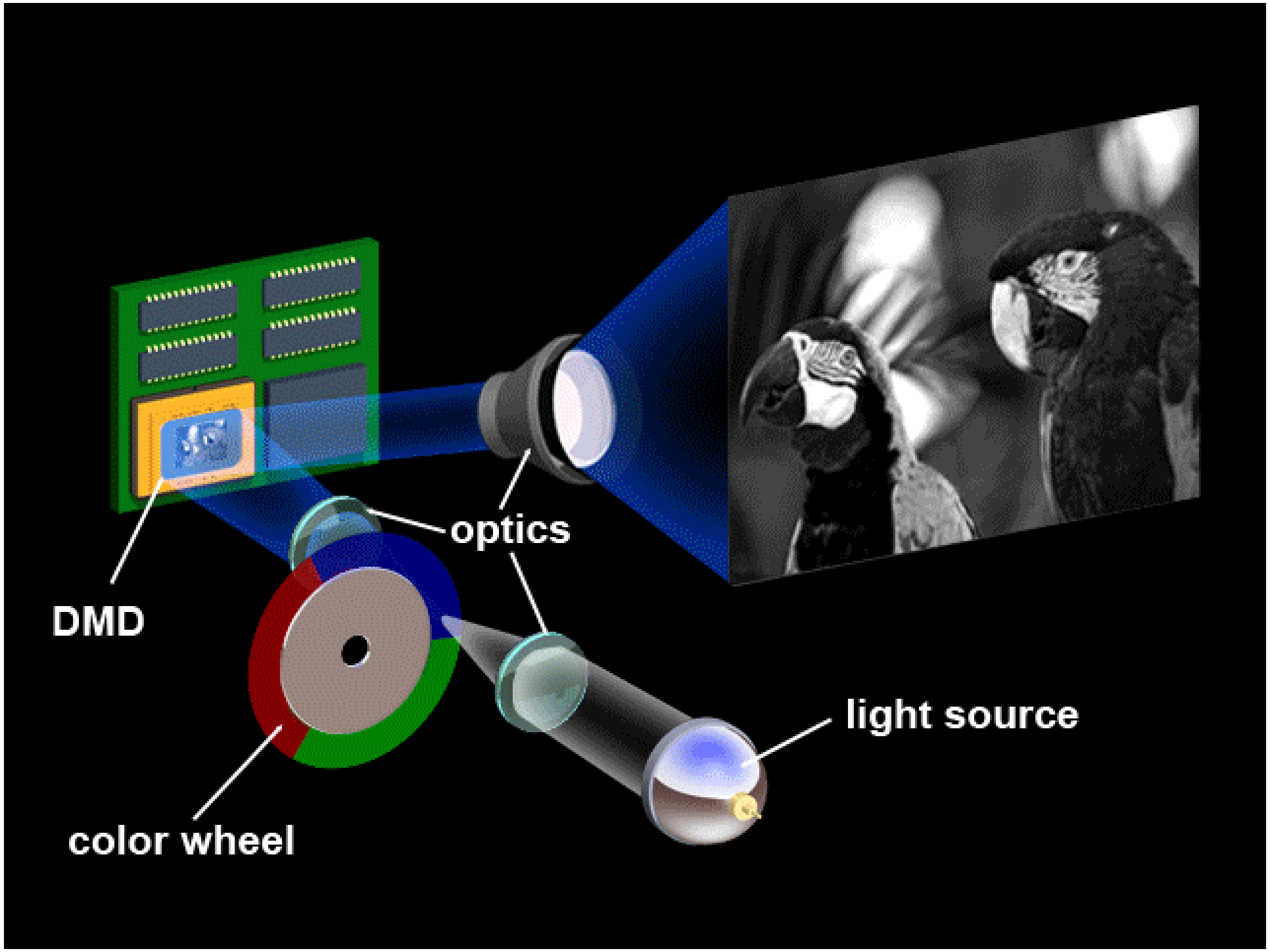
How DLP technology works



How DLP technology works

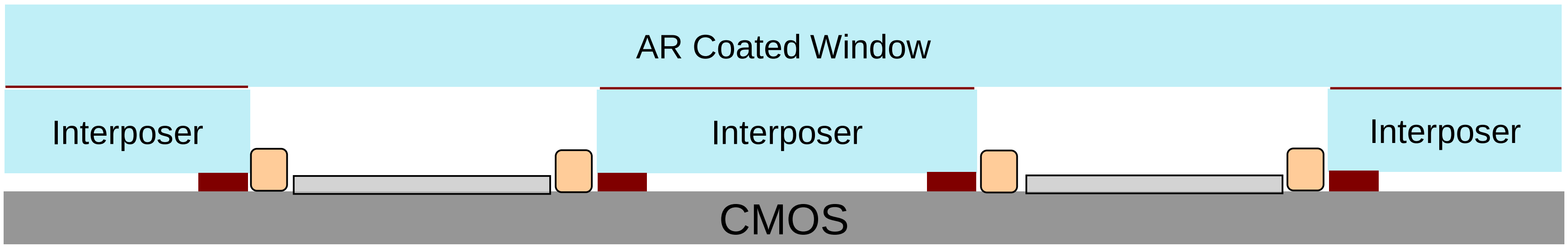


How DLP technology works



What I work on

- Process development engineer
  - Stiction (static friction)
- Projects
  - “Fundamental understanding” of headspace
  - Wafer-level packaging
  - New applications



Benefits of Physics PhD – Example

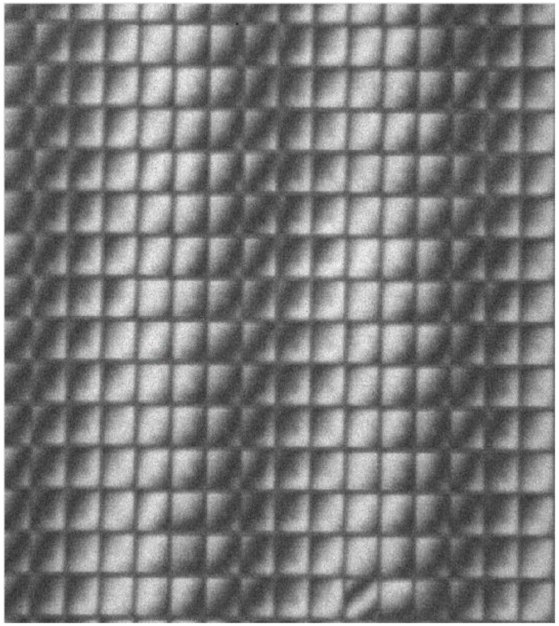
- Problem: Ongoing moisture permeation problem with specific device.
  - Abnormally large distribution of moisture in package.
- Hypothesis: Poor UV curing of epoxy at bondlines, resulting in excessive moisture permeation.
  - No clear reason why these devices had uncured epoxy while epoxy in other devices was cured.
- While working on another project, I noticed peculiarities in the interferometric measurements on these devices.
  - These peculiarities had been observed by others but had been disregarded.

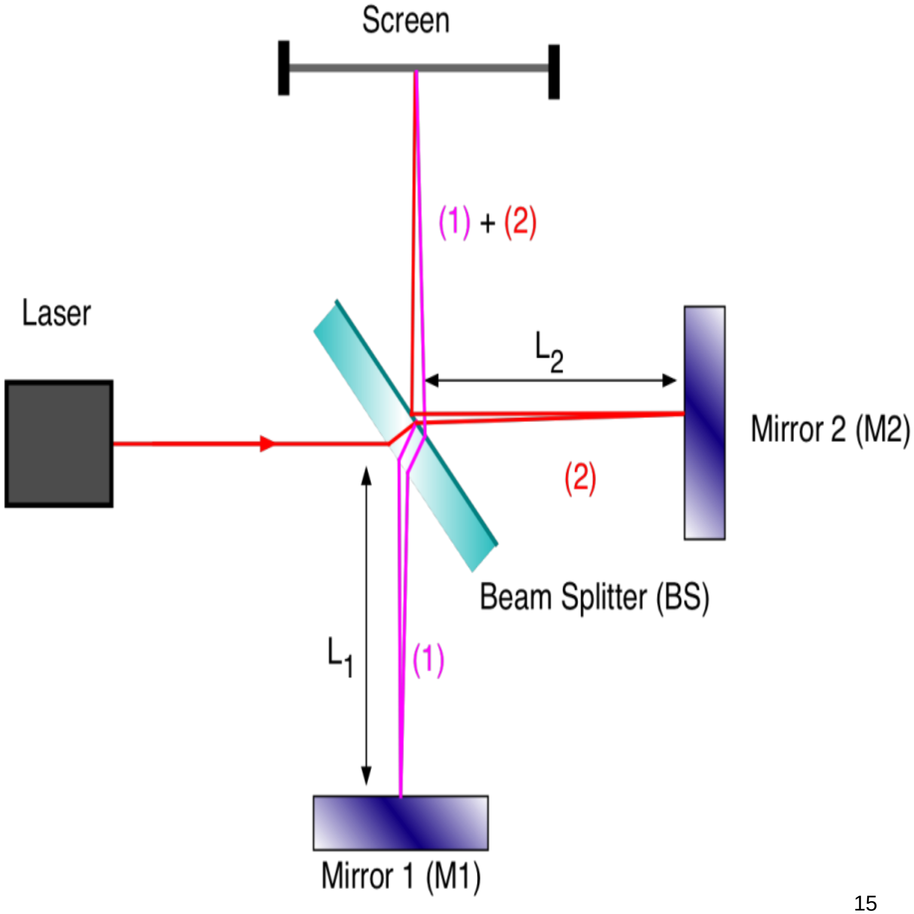
The following slides are from a presentation I gave shortly after I started this job.

Interferometry peculiarities observed

Observation #1: All dies from a single wafer showed very similar modulation % values of either 30-40% or 10-20%.

Observation #2: Modulation % values changed between some wafers.



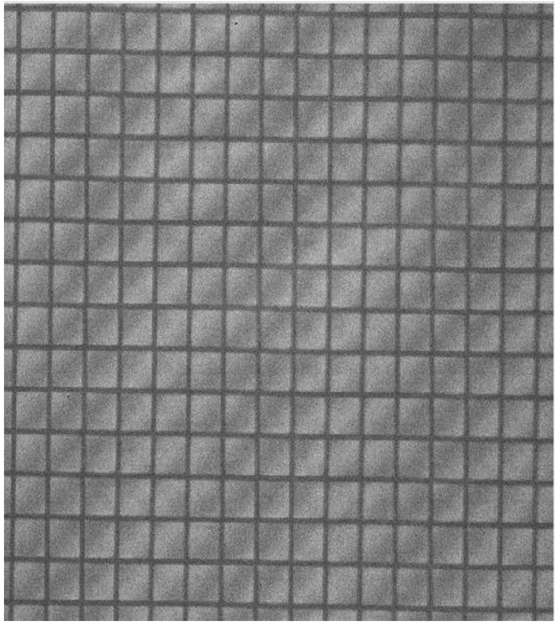


Modulation %

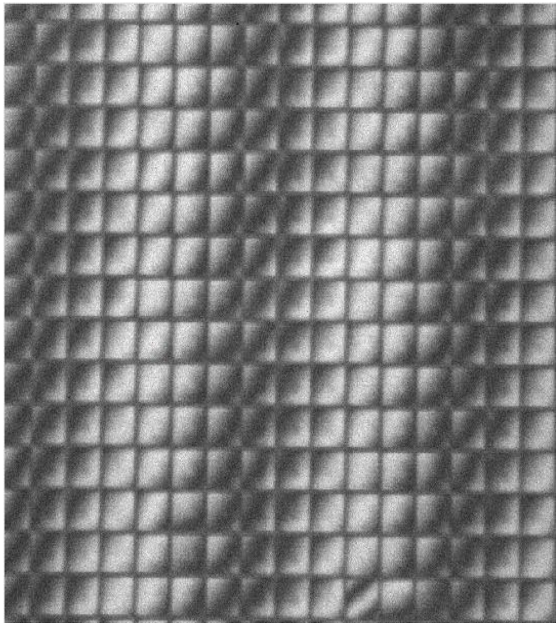
Modulation % is like a contrast ratio of the fringes.

- 10-20% is “bad”, data is swamped by noise.
- 30-40% is “good”, data quality looks good.

Modulation 14%



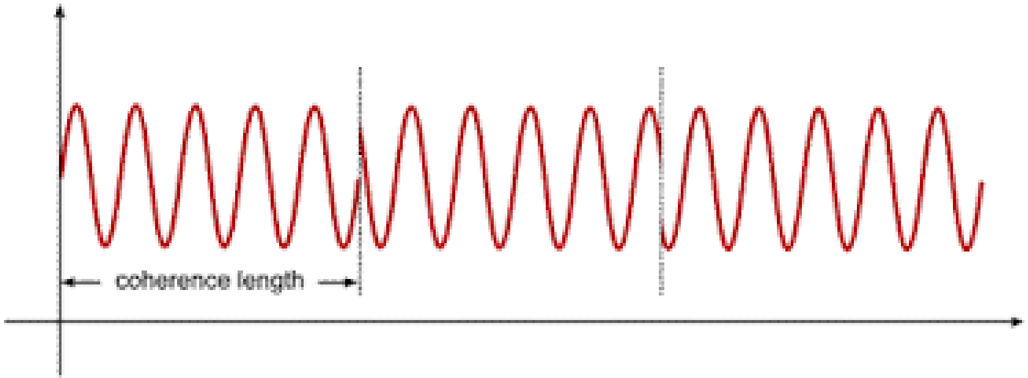
Modulation 40%



Understanding modulation %

Interferometry Basics

- Interference pattern (fringes) requires coherence length to be greater than optical path length difference between splits beams.
  - Optical path length (OPL) = (index of refraction of medium)*(length of travel)
  - In this case, light source is blue LED and has CL = 4.7 microns.
- Ideally, the split beams should have the same intensity when they recombine.
  - Modulation % is maximized for equally intense beams.



$$E_{TOTAL}^2 = (\underline{E}_1 + \underline{E}_2)^2 = E_1^2 + E_2^2 + 2\underline{E}_1.\underline{E}_2$$

What could cause modulation % variations?

OPL Differences

- Window thickness
- Index of refraction

Relative Beam Intensities

- Transmissions due to AR coating differences
- Window thickness
- ~~Reflectivity of the mirror array*~~

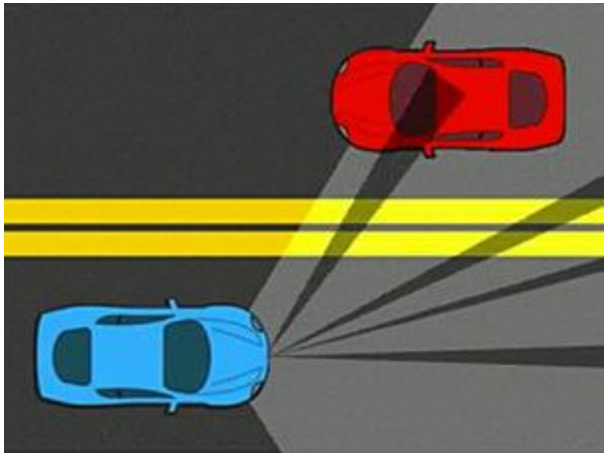
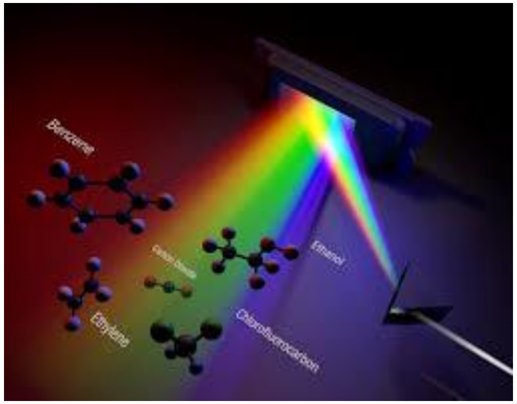
Further experiments showed that windows from supplier had two distinct flavors, which had subtle differences in both window thickness and AR coating transmission properties.

- Window thickness differences likely accounted for what I observed.
- Transmission properties accounted for poor UV curing of epoxy.

*Ruled out by experiment where I swapped the windows

What I like about my job

- Interdisciplinary
- Team environment
  - Work alongside some other PhDs from different fields, but mainly surrounded by BSs in mechanical and electrical engineering
- Mature technology, but impacts can still be made
- Work stays at work
- Cool technology with interesting applications still to come

https://www.youtube.com/watch?v=-8L7iKaW25o

Final words

- My advice for getting a job in industry:
  - Make a contact with someone in the company (networking)
  - Show interest/passion for the position or technology
- If you're worried about early job performance like I was:
  - You'll learn the job on the job
  - They hired you knowing you currently are not an expert
- Feel free to connect with me on LinkedIn or e-mail me at t-byrum@ti.com

Thank you!