Minimizing Distortion and Increasing Resolution in Wide-angle Viewing by Means of Actuated Micro-mirrors

SUNFEST REU PROGRAM

Student: William Rivera Rodríguez

Advisors: Dr. Suresh G. K. Ananthasuresh

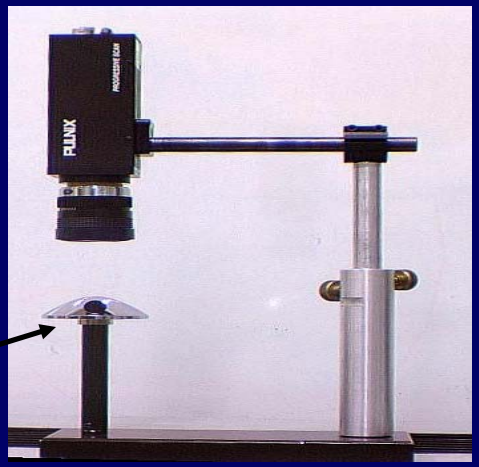
Dr. Andrew Hicks

Outline

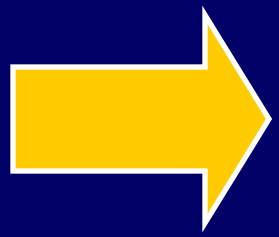
- Research Motivation
- Project Goals Description
- Results
- Future Work
- Questions

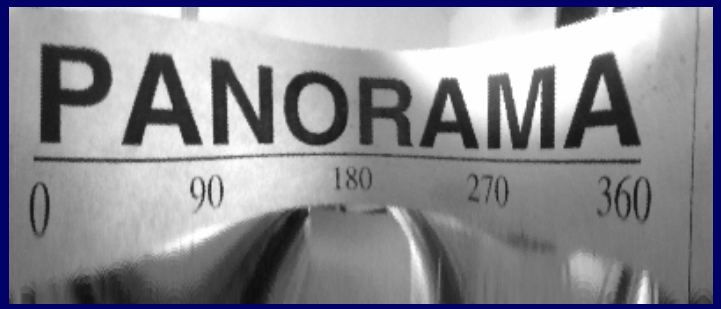
Research Motivation

- ***Distortion in wide angle viewing***



mirror

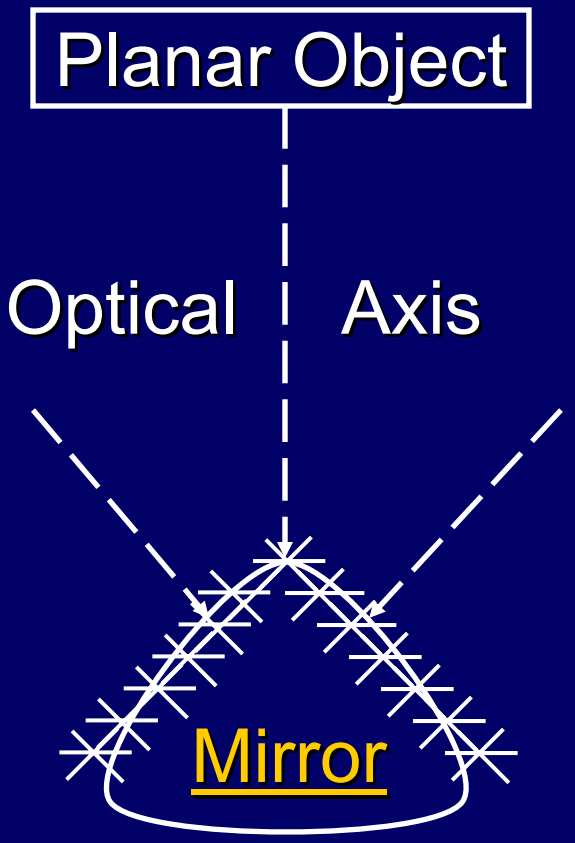




Photos from: http://cmp.felk.cvut.cz/demos/Omnivis/

Project Motivation

- **Problem 1:** Paraboloidal vs. spherical
- **Research:** Distortion minimization has been achieved to the optical axis
- **Problem 2:** Change the optical axis and still have an undistorted image



Research Motivation

- ***Image resolution*** - refers to the spacing of pixels in an image and is measured in pixels per inch (ppi) or dots per inch (dpi).

72 dpi

36 dpi

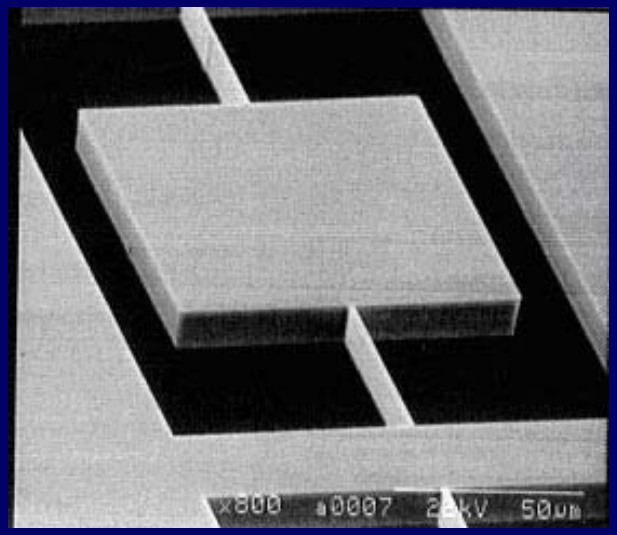
Pictures from: http://www.ieee.org/organizations/pubs/magazines/imageres.htm

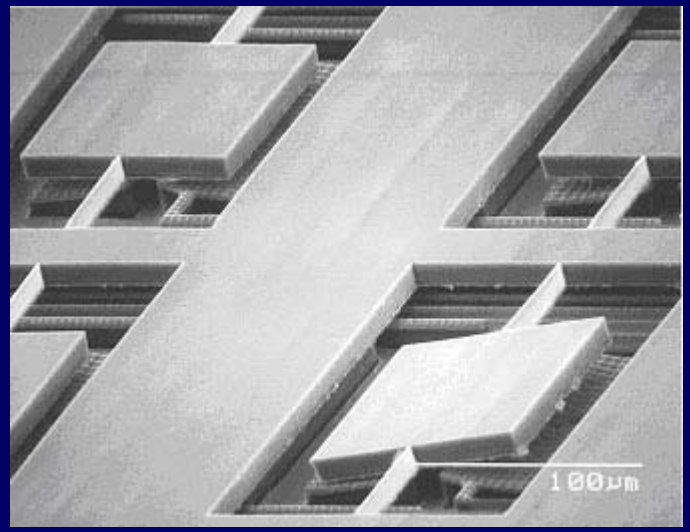
Project Goals

- Single axis micro-mirrors design and construction
  - Masks Design
  - Use (110) silicon wafer
  - Fabrication
  - Mechanical Modeling
  - Actuation if possible

Research Goals

- Application – Video Cameras
- Micro-mirror – University of California, Santa Barbara MEMS Research



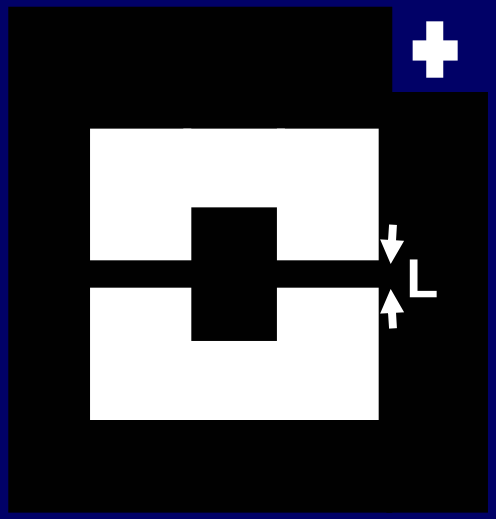


Pictures from:
http://www.engineering.ucsb.edu/~memsucsb/Research/Sructural/Materials_Selection/Adv_MEMS.htm

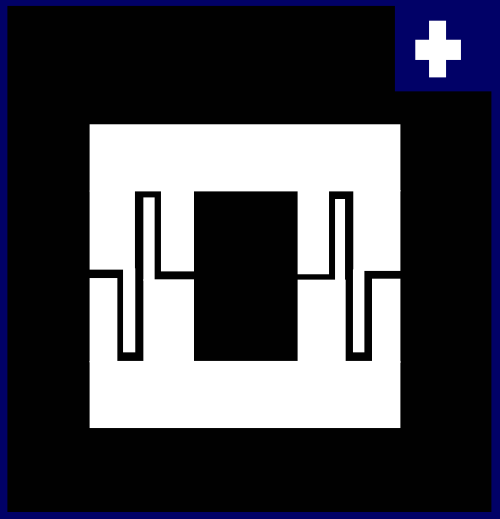
Results

- The Mask Design was developed with the use of AutoCAD

Single-axis micro-mirror

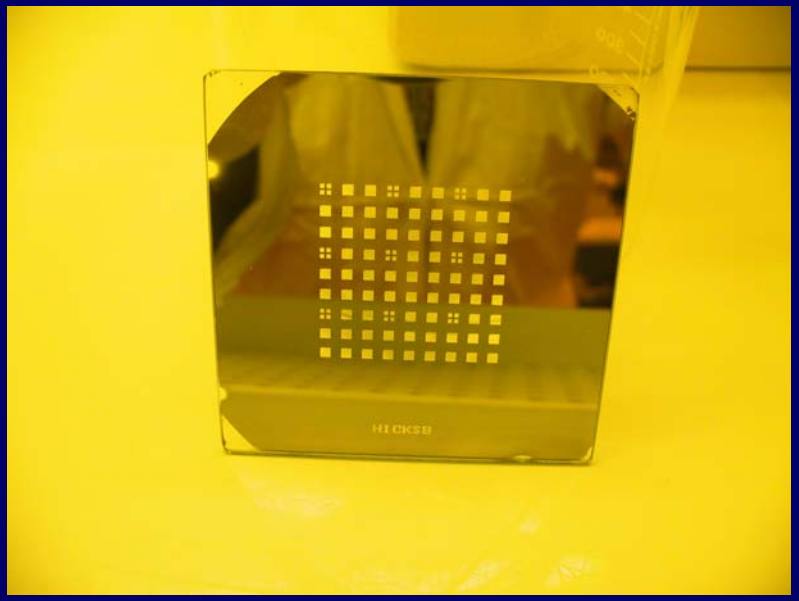


Serpentine spring micro-mirror



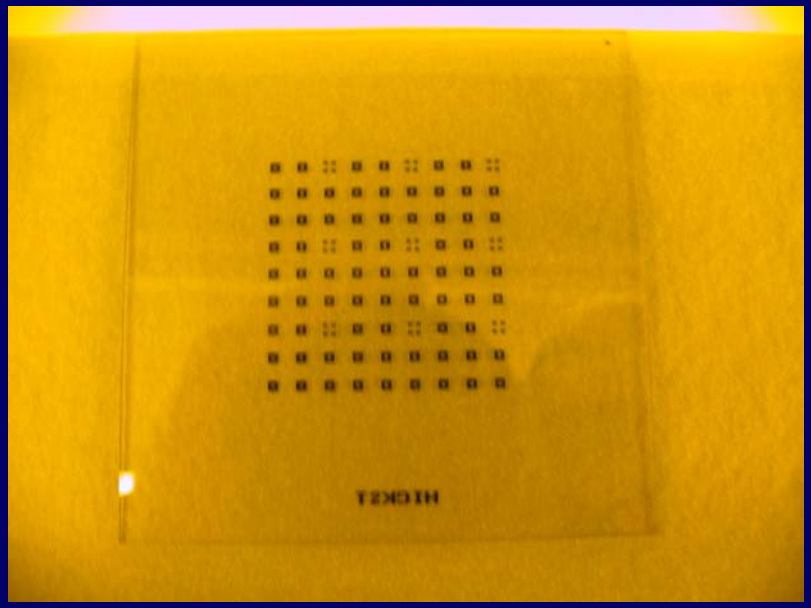
Results

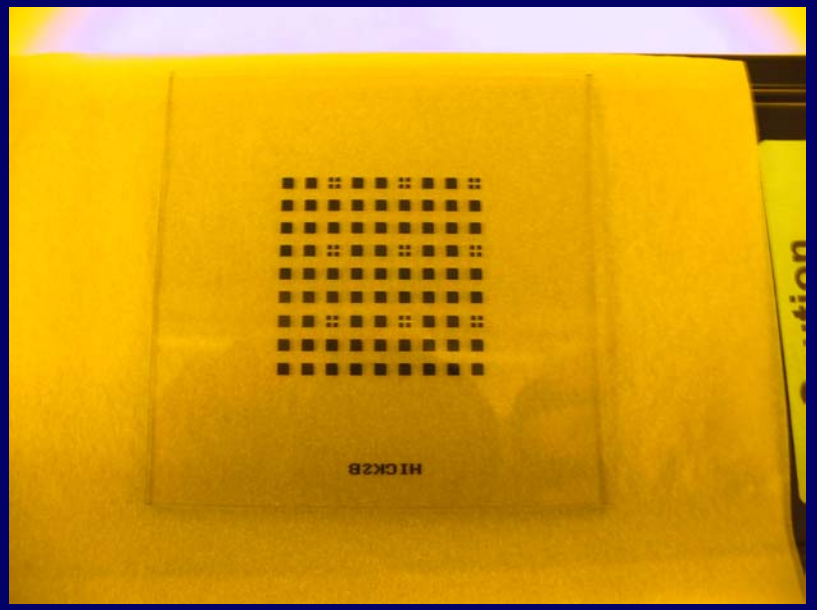
- The first fabricated masks have the wrong polarity.



Results

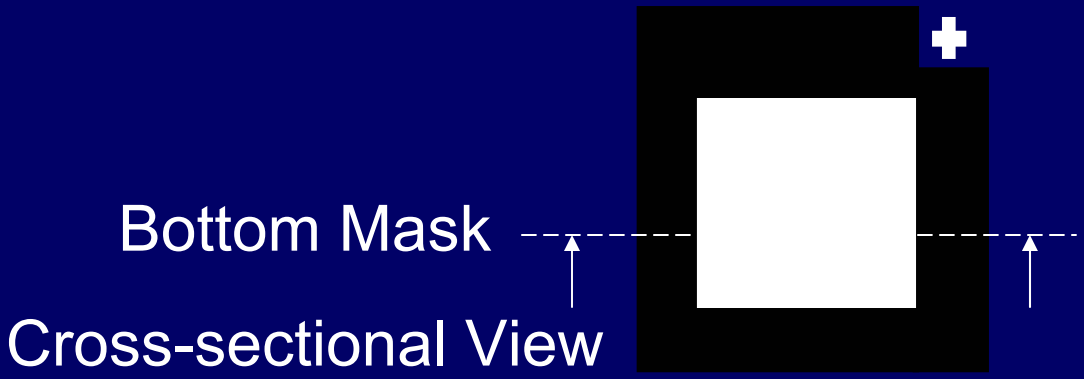
- **Mask Design**
  - Top and Bottom masks with correct polarity

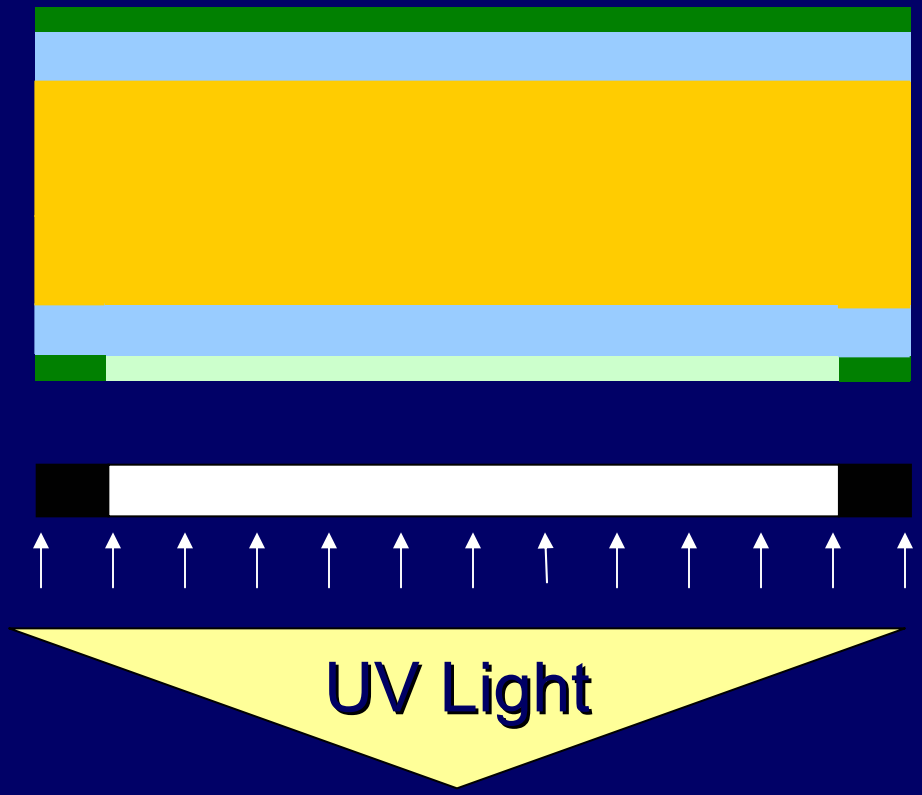




Results

- Process Flow





(110) Silicon Wafer

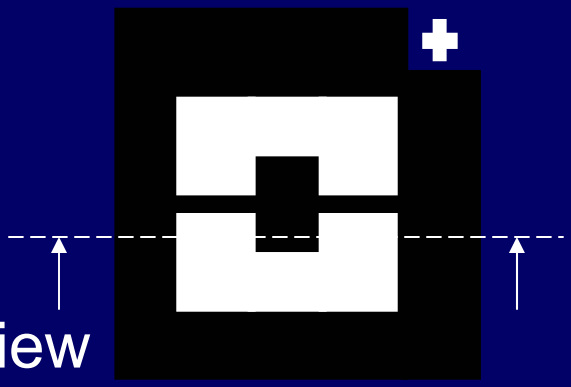
Silicon Oxide Layer

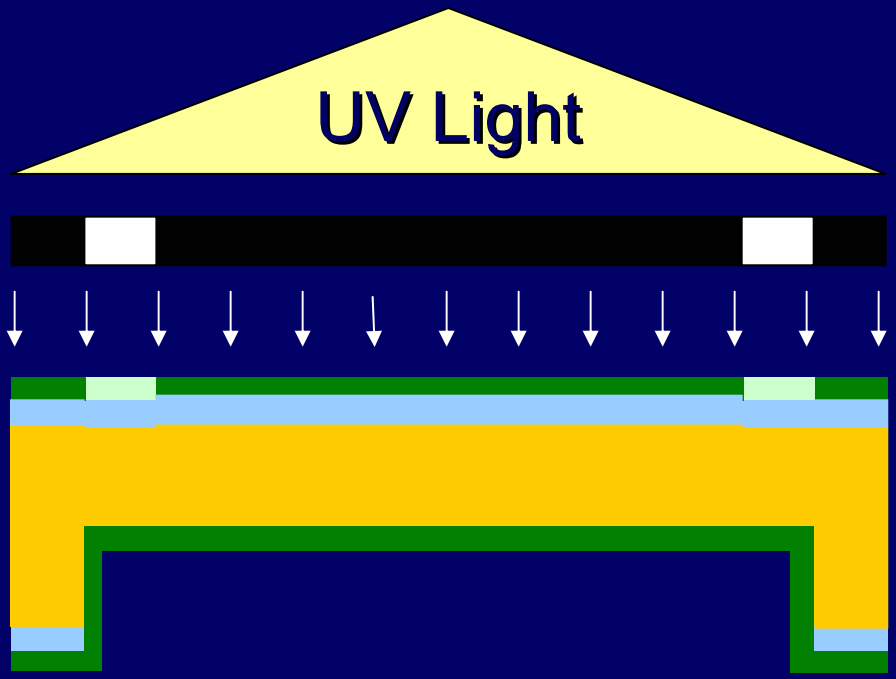
Photoresist Layer

Exposed Resist Layer

Results and Discussion

- Process Flow





Silicon Wafer

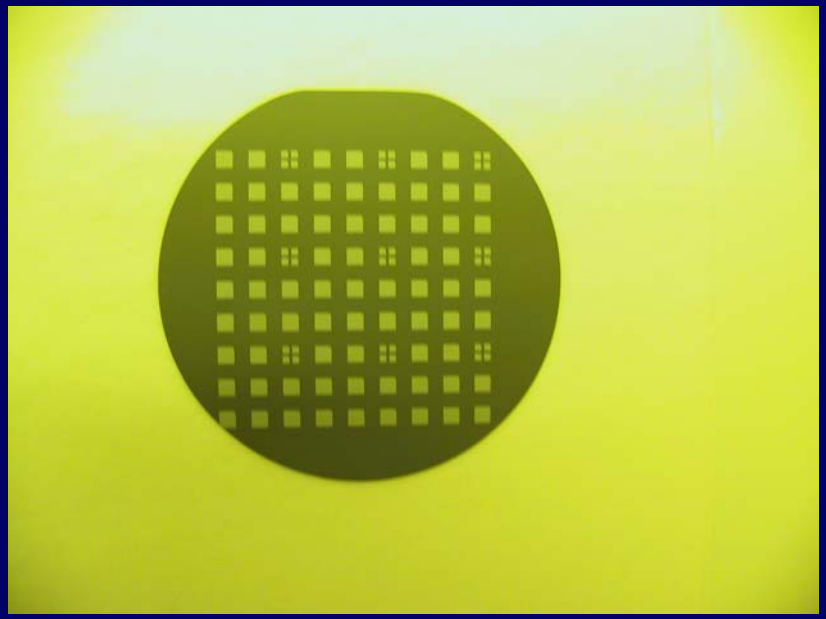
Silicon Oxide Layer

Photoresist Layer

Exposed Resist Layer

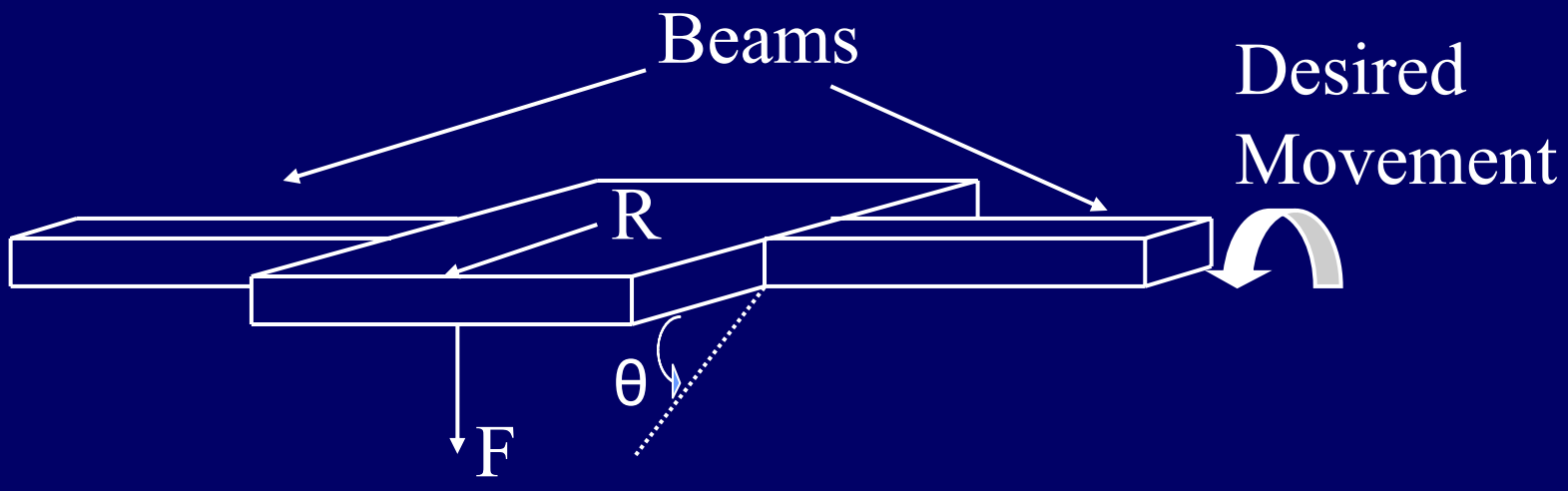
Results

- The silicon wafer processing was stopped at the photoresist stripping of the bottom pattern.



Results

- The Mechanical Modeling



Results

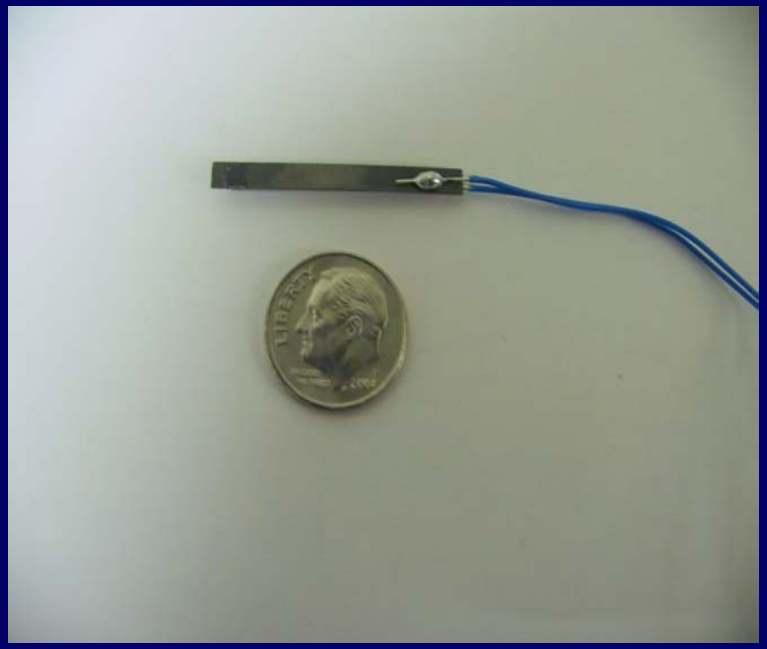
- **Force and torque results for different Poisson's ratio = v**

- At E = 2.4 GPa and v = 0.4
- T = 0.1627 N·m, F = 32.5173 N

- At E = 2.4 GPa and v = 0.5
- T = 0.1518 N·m, F = 30.3494 N

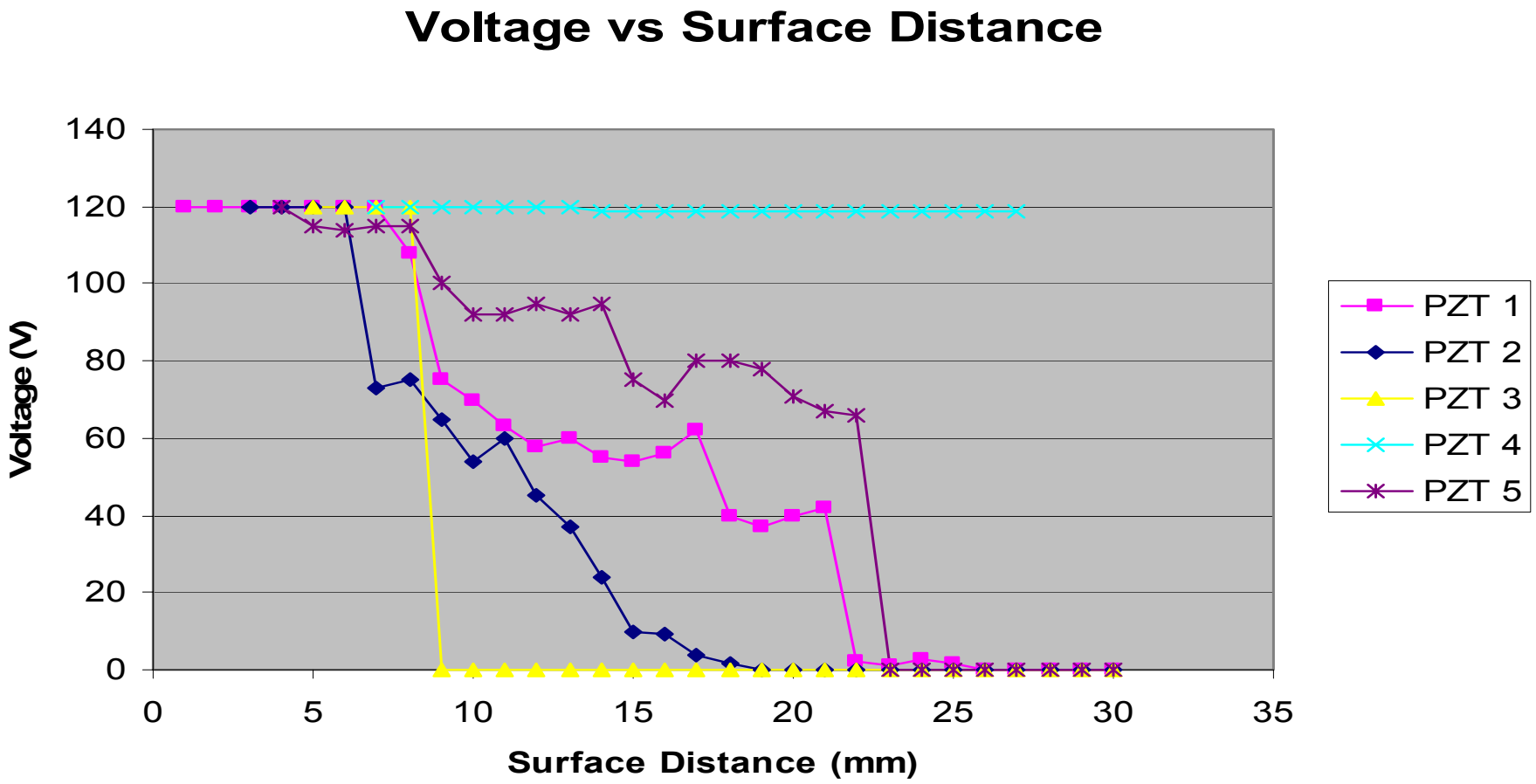
Results

- Actuation Approach
  - Of the piezoelectric material sheets only two were able to move when 120V were applied across them.
  - Measurements of the voltage across its surface showed an uninformed charge density.



Results

- Actuation Approach



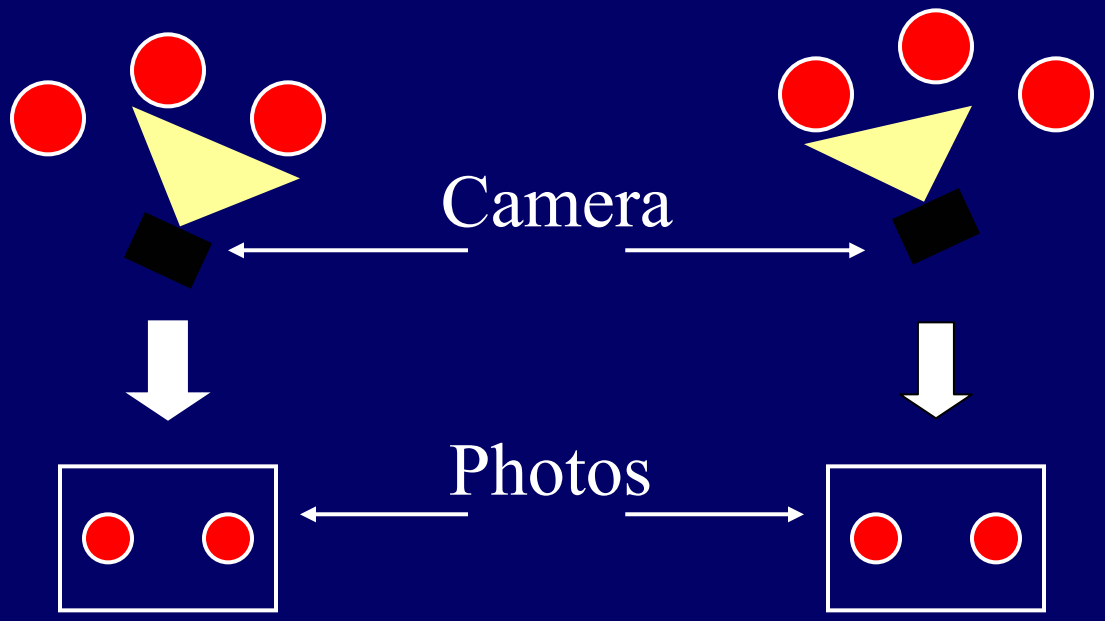
Future Work

- Finish the single axis micro-mirrors fabrication
- Design the micro-mirrors actuation at the macro and micro levels
- Explore a two axis micro-mirror fabrication

Questions

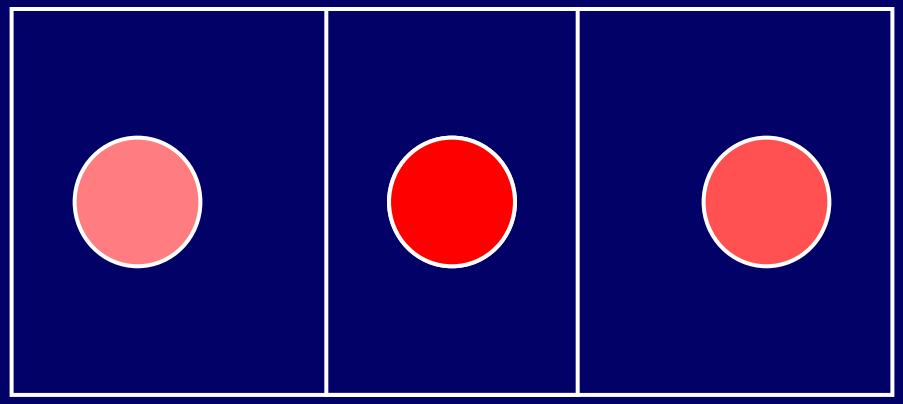
Research Motivation

- Image Resolution Proposed Method



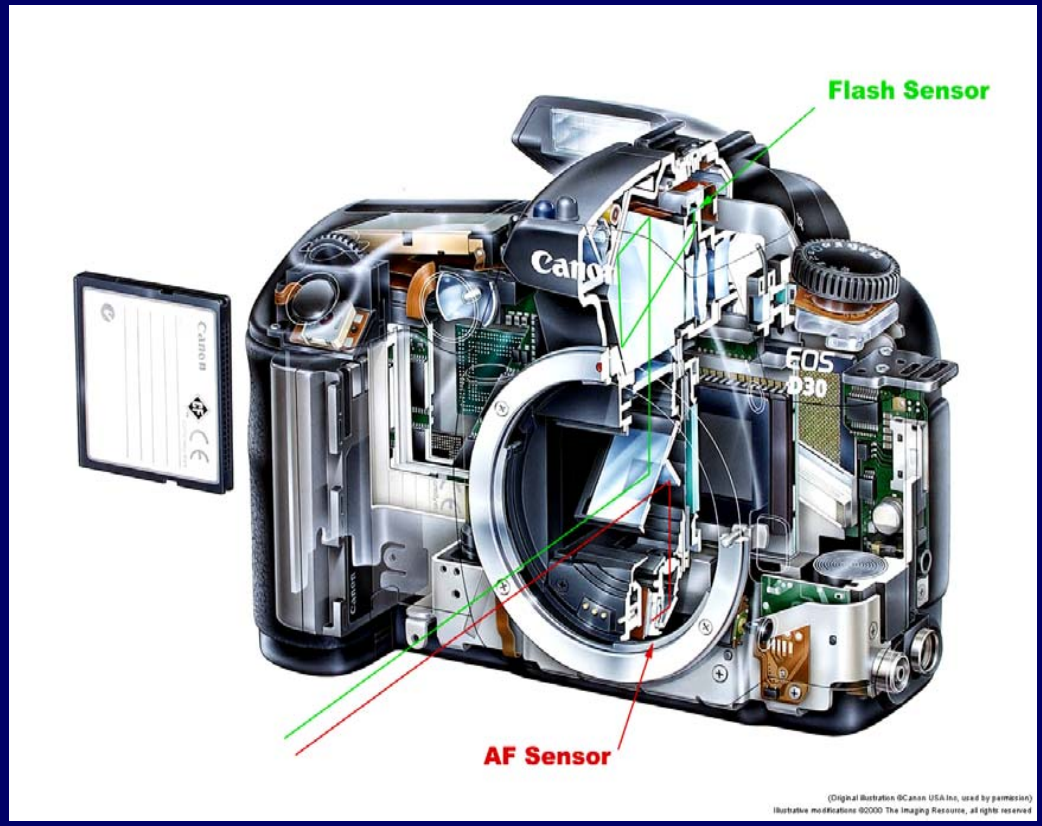
Background of the project

- Image Resolution Proposed Method
  - Overlapped Pictures



Research Motivation

- Image Resolution Proposed Method



http://www.imaging-resource.com/PRODS/D60/D60P.HTM

Extras

- Advantages of KOH Wet Etching
  - Insensitive to layout
  - Uniformity ±5% in wafer
  - Little maintenance support
  - Lower Cost