# Digital Micromirror Devices

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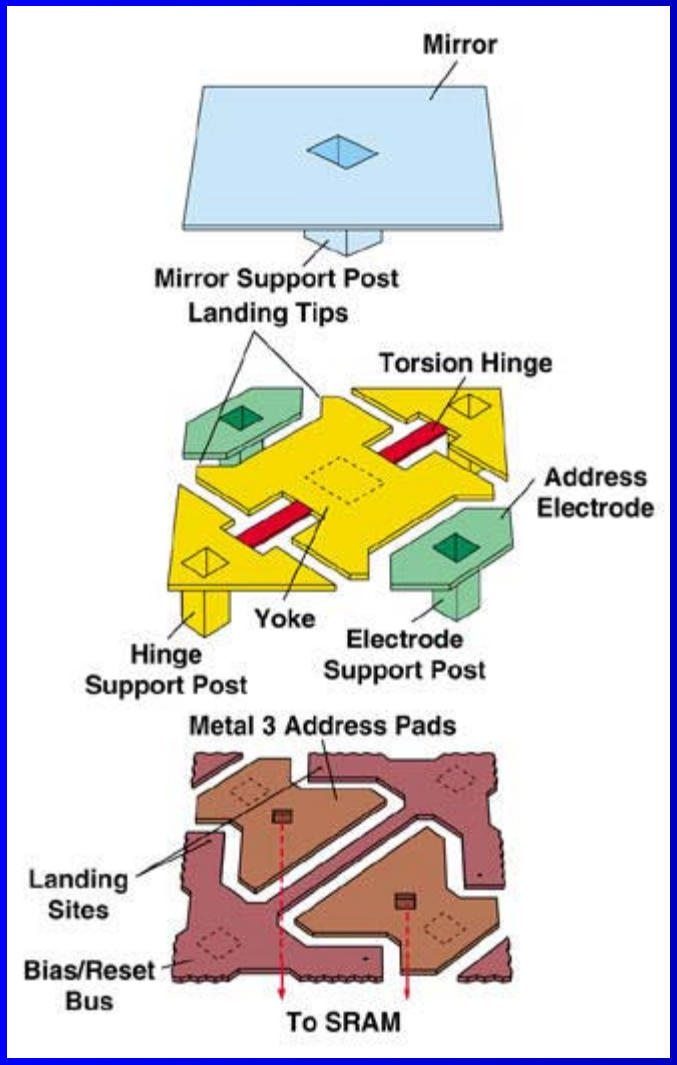
ECE 6450

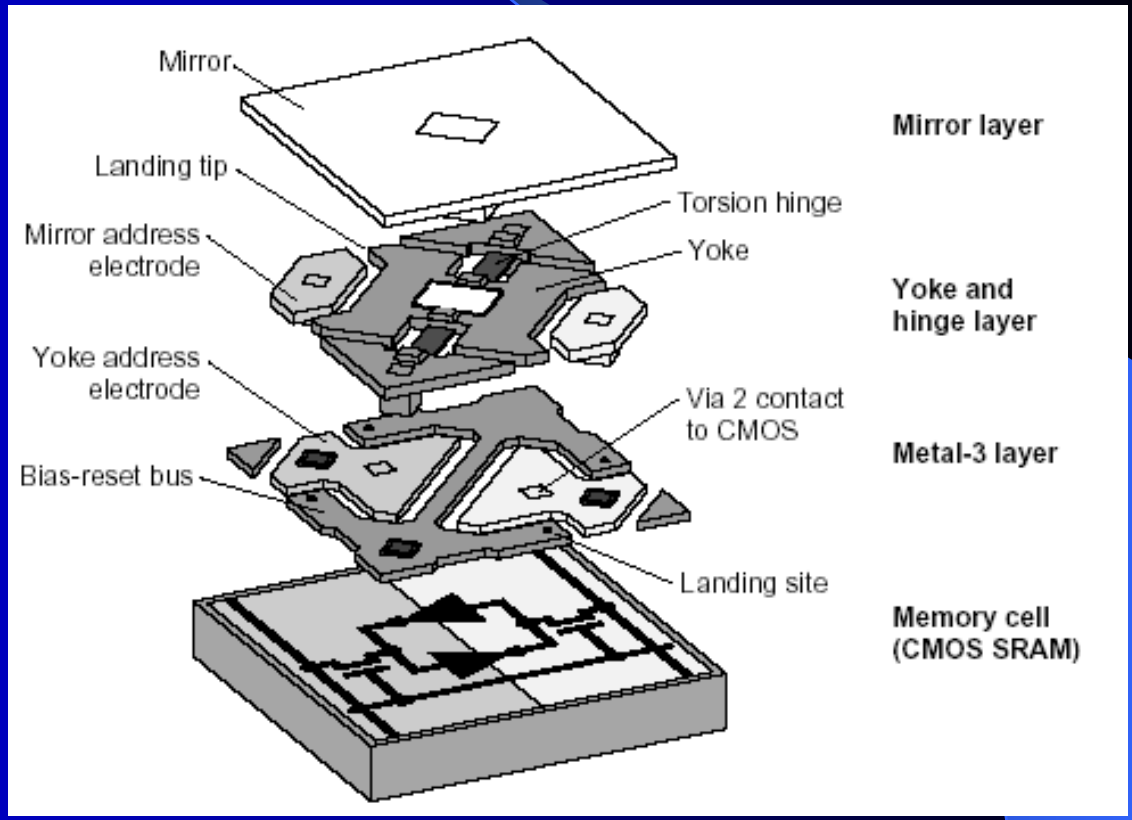
November 18, 2002

# Digital Micromirror Devices

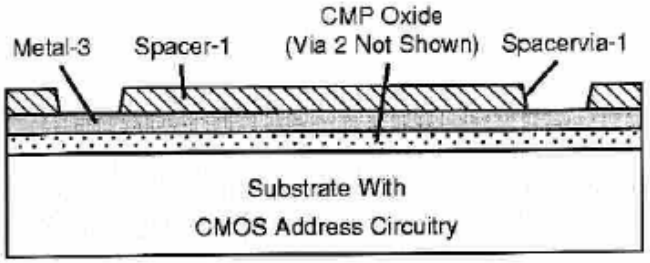
- Design
- Fabrication
- Specifications
- Specific Design Problems
- Applications
- Questions

# Structure

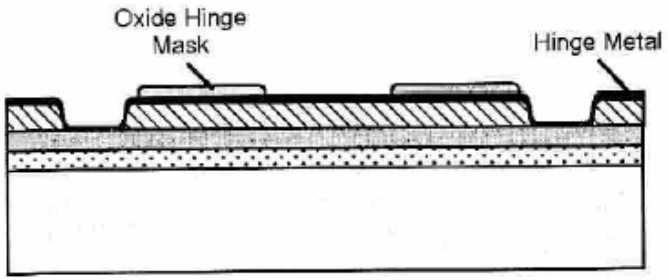

Mirror
Mirror Support Post
Landing Tips
Torsion Hinge
Address Electrode
Yoke
Hinge Support Post
Electrode Support Post
Metal 3 Address Pads
Landing Sites
Bias/Reset Bus
To SRAM


Mirror
Landing tip
Mirror address electrode
Yoke address electrode
Bias-reset bus
Torsion hinge
Yoke
Via 2 contact to CMOS
Landing site
Mirror layer
Yoke and hinge layer
Metal-3 layer
Memory cell (CMOS SRAM)

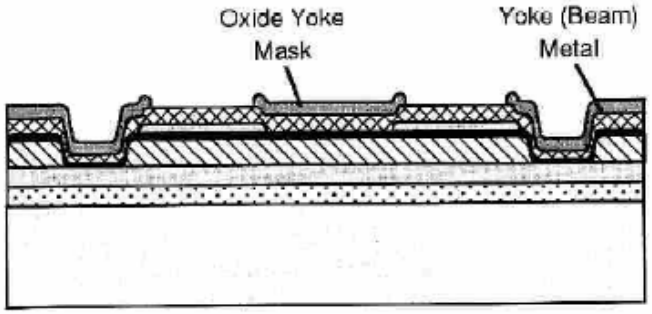
# Fabrication Detail



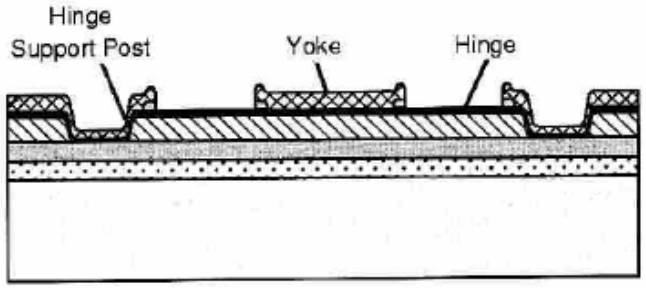

After Spacer-1 Patterning



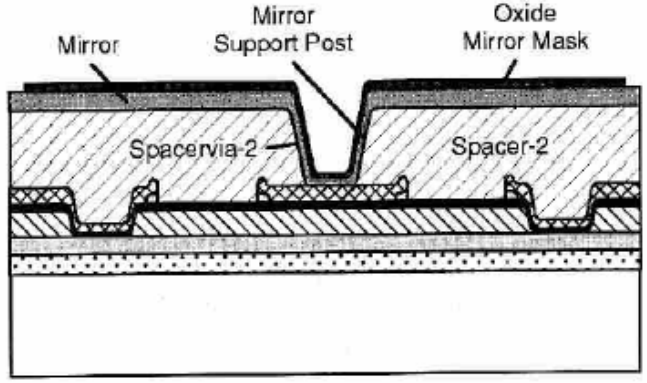

After Oxide Hinge Mask Patterning



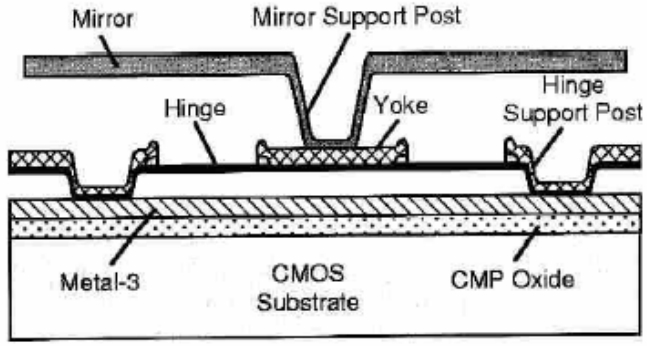

After Yoke Oxide Patterning




After Yoke/Hinge Etch and Oxide Strip

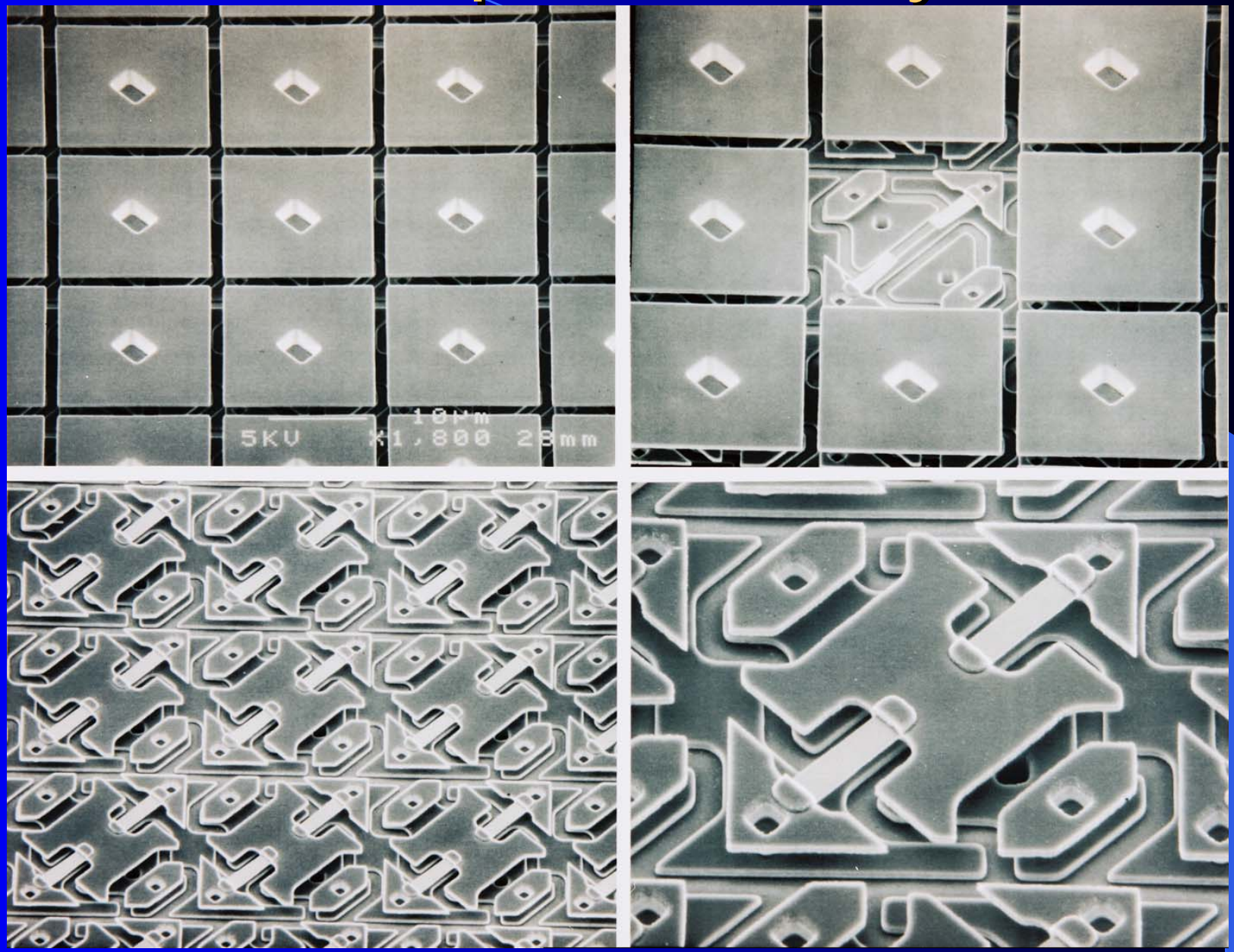



After Mirror Oxide Patterning




Completed Device

# Completed Array



# Specifications

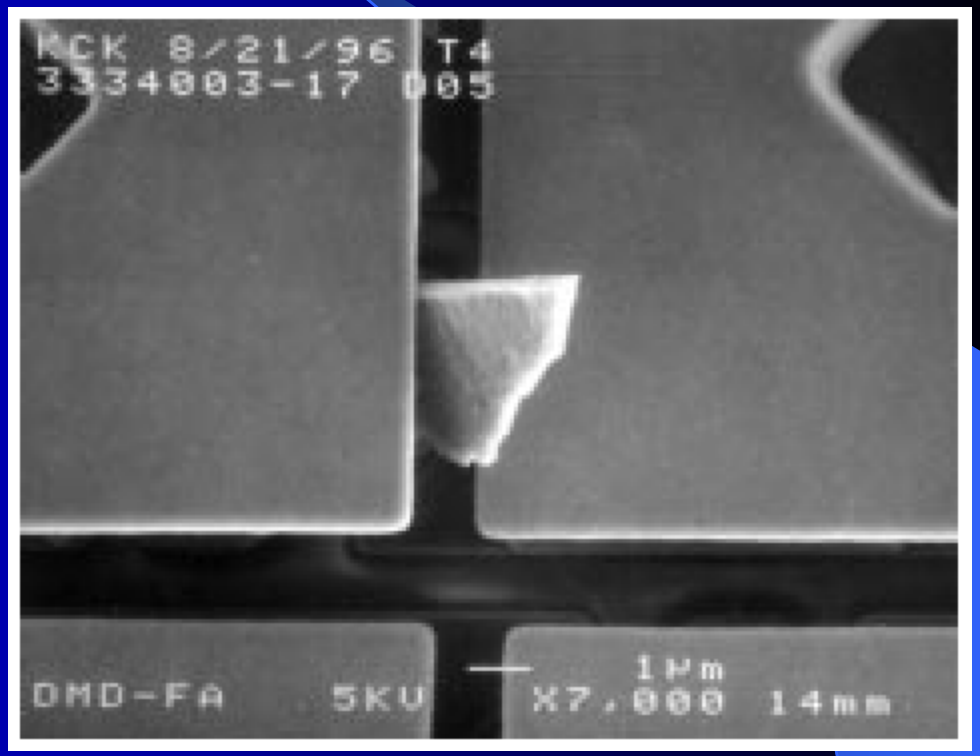
| | |
|---|---|
| Mirror Size (TI's DLP) | 16µm x 16µm |
| Mirrors per chip | 0.5 – 1.2 million |
| Mirror Element | Aluminum |
| Lifetime Usage | 450 billion contacts/part |
| CMOS Voltage | 5V |
| CMOS Process Size | 0.8µm |
| CMOS Design | Standard SRAM Cell |

# Design Considerations

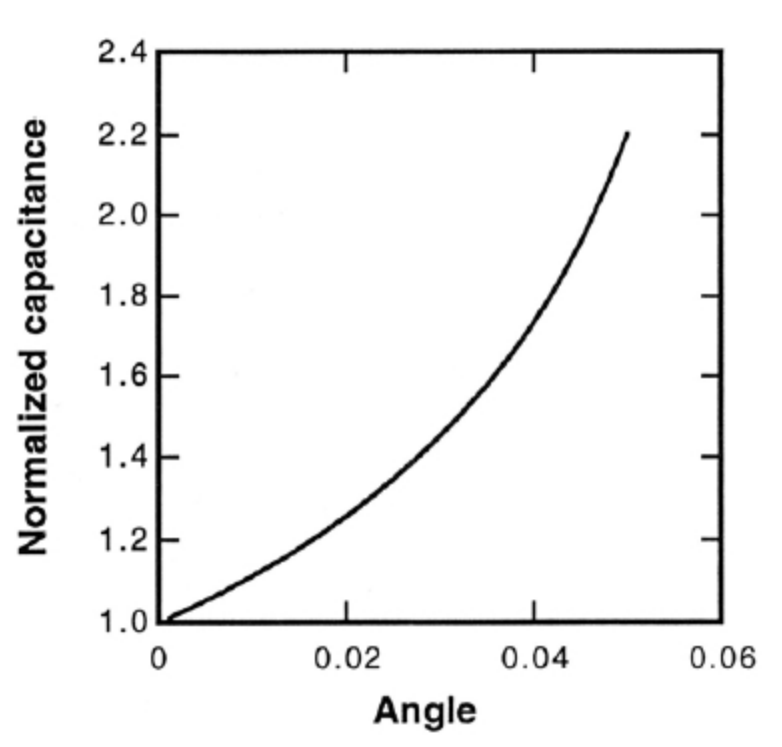
- Strict x, y, and z plane requirements
- Particle Control
- Physical contact during operation (tips)
- Optical lid and other packaging have tight design requirements
- Testing requires specialized equipment

# Particle Control

- 1μm gaps between mirrors
- 0.2μm interlevel gaps during operation
- Specialized Cleaning Process Required



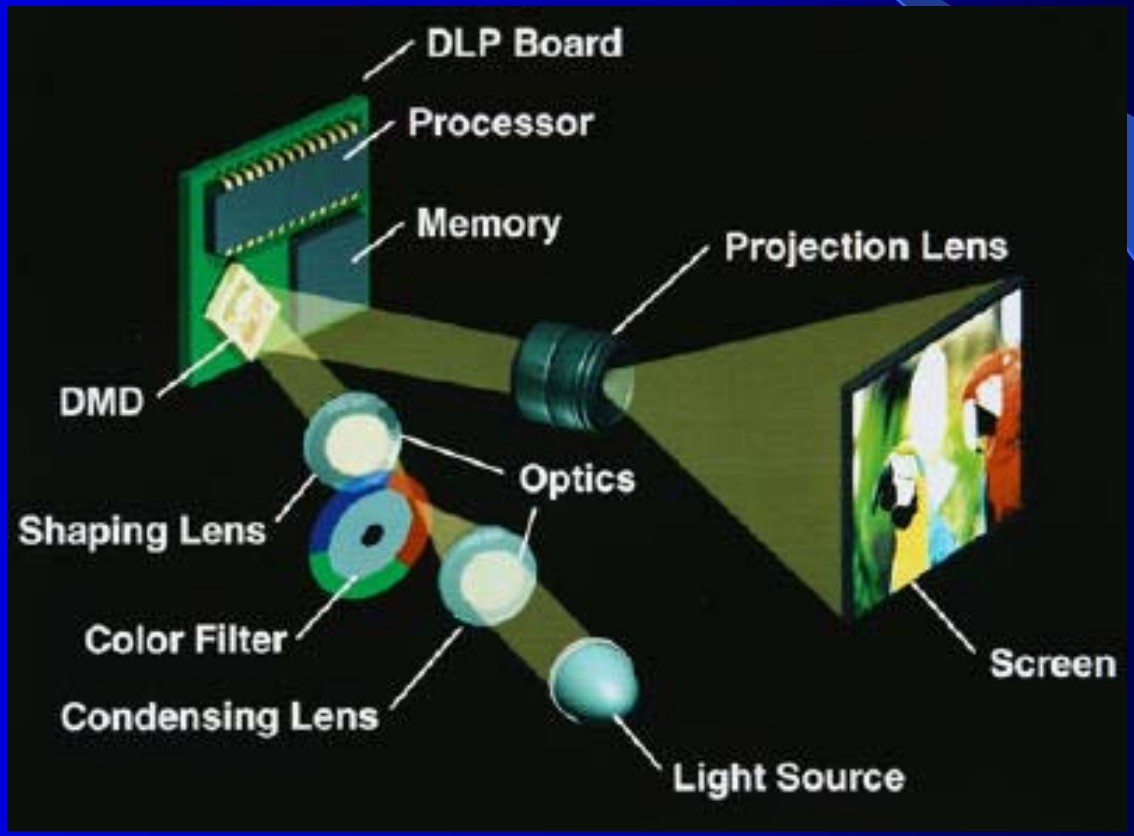
# Control Equations




$$V_{PI} \propto \frac{1}{\sqrt{C}}$$

In most cases, there is only an on and off setting, so the CMOS understructure is designed for optimum voltage

# Applications: Projection Display



# Applications

- Variations on Projection Display:
  2-chip and 3-chip
- Fiber Optic Switching:  N x N matrices
  - reliable, fast
  - Lucent uses micromirrors in many fiberoptic applications
  - 20ns switching speed

# Conclusions

- Once the chip is made, it's hard to break.
- DMD technology is the current leader in spectacular high definition TV and projector design.
- Further research into even tighter designs and better switching times can impact fiber optics further.

# Questions?