Extensions to the Chatoyant O/E CAD Framework for Modeling Micro-Opto-Electrical Systems

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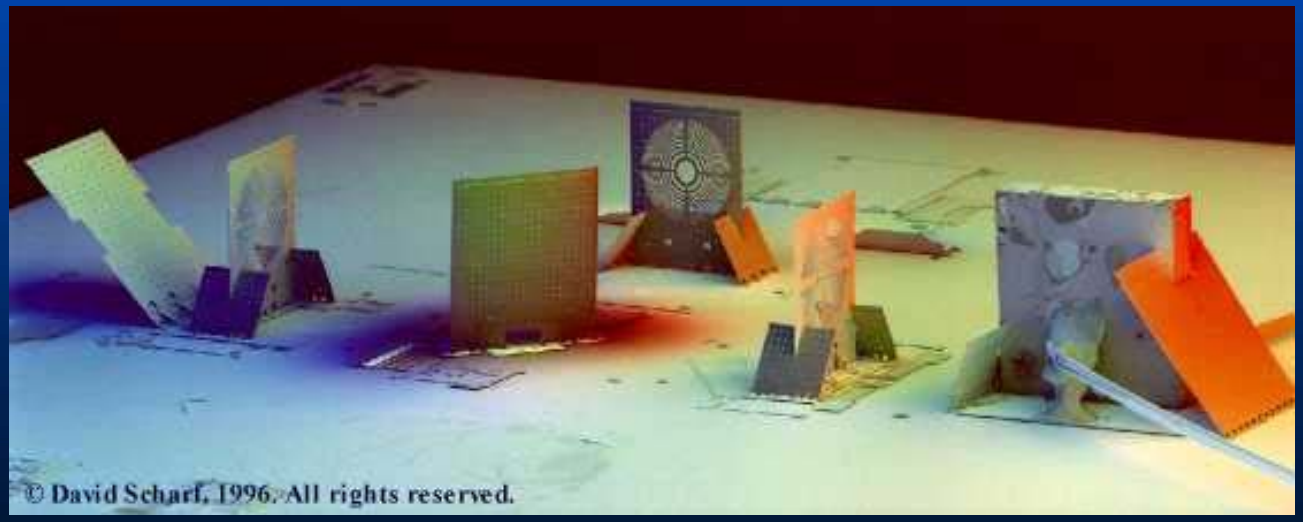
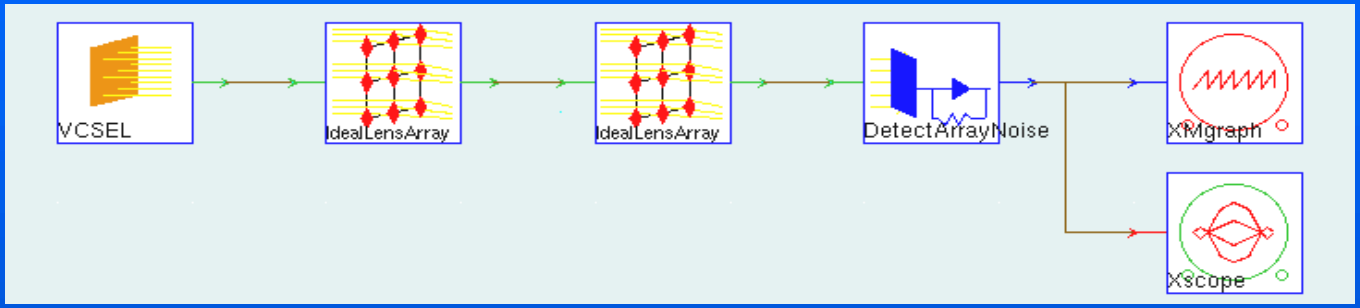
Overview

- *Chatoyant*
- Extensions for Micro-Opto-Electronic Modeling
- 3D FFT System
- Optical MEM Systems
- Conclusions



Ming Wu - UCLA - Integrated Free-Space Optical Disk Pickup Head
http://www.ee.ucla.edu/labs/laser/

Chatoyant

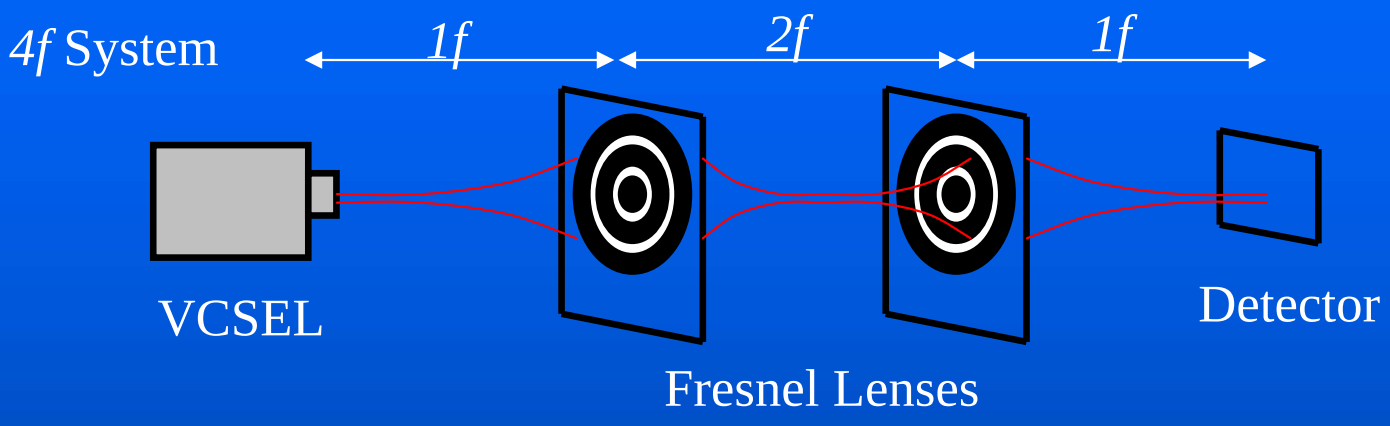


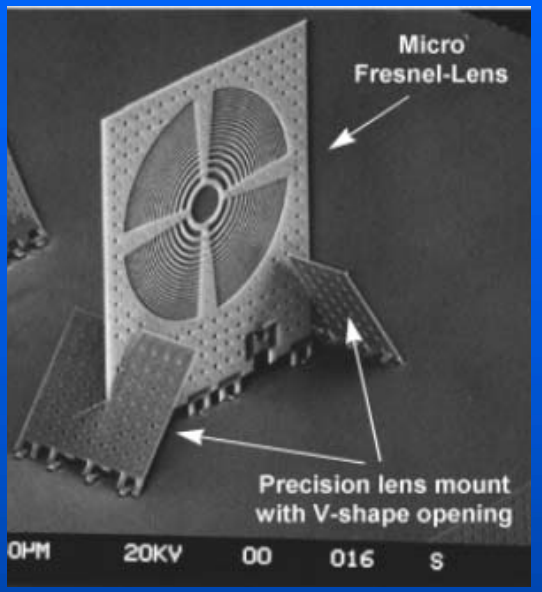
- Mixed Signal, Free-Space, Opto-Electronic Simulation Framework
  - Analyze: system efficiency, insertion loss, crosstalk, BER, mechanical tolerancing
- Built on Ptolemy (UC Berkeley)
  - Icons, called “stars”, are the component models
    - Analytic, empirical, and “lumped parameter” models
  - Lines, or “wires”, are the signal paths
    - Passes “message” class
    - Supports electrical and optical signals & concept of time

Extensions for Micro-optical Simulation

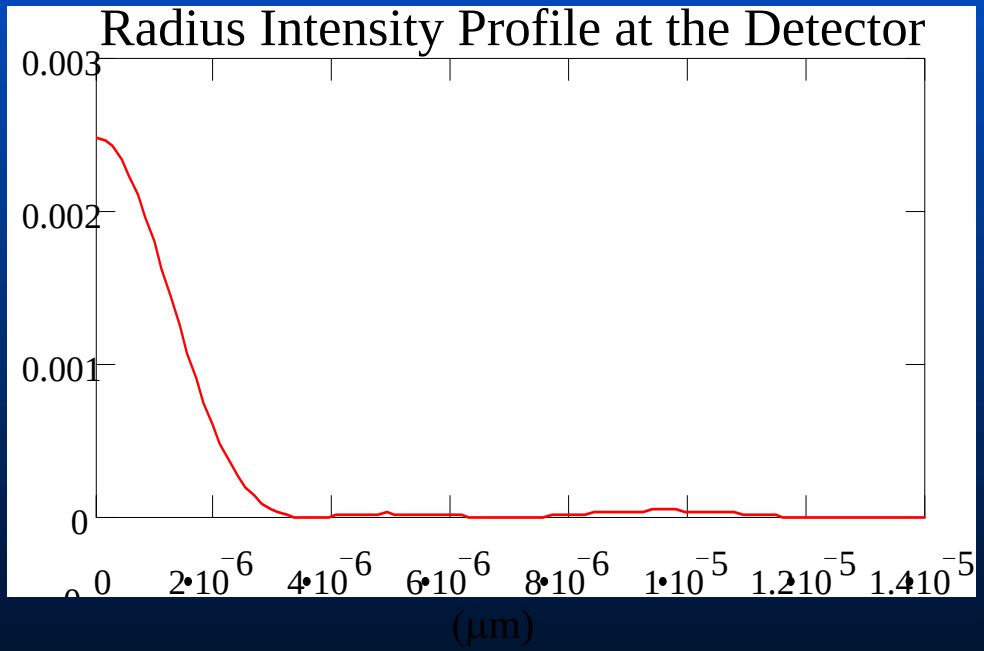
- Models for Diffractive Optics
  - In micro-optical systems, we are interested in both near and far fields, therefore, we use the Fresnel Approximation
- New Component Models
  - Micro-Mirrors, Micro-Lenses, Phase Masks
- Monte Carlo Tolerancing Package
  - Probability Distributions (Uniform, Gaussian) instead of Specific Component Values
  - Analyze “best” and “worst” case results - Sensitivity Analysis

Optical Models - Diffractive Fresnel Lens





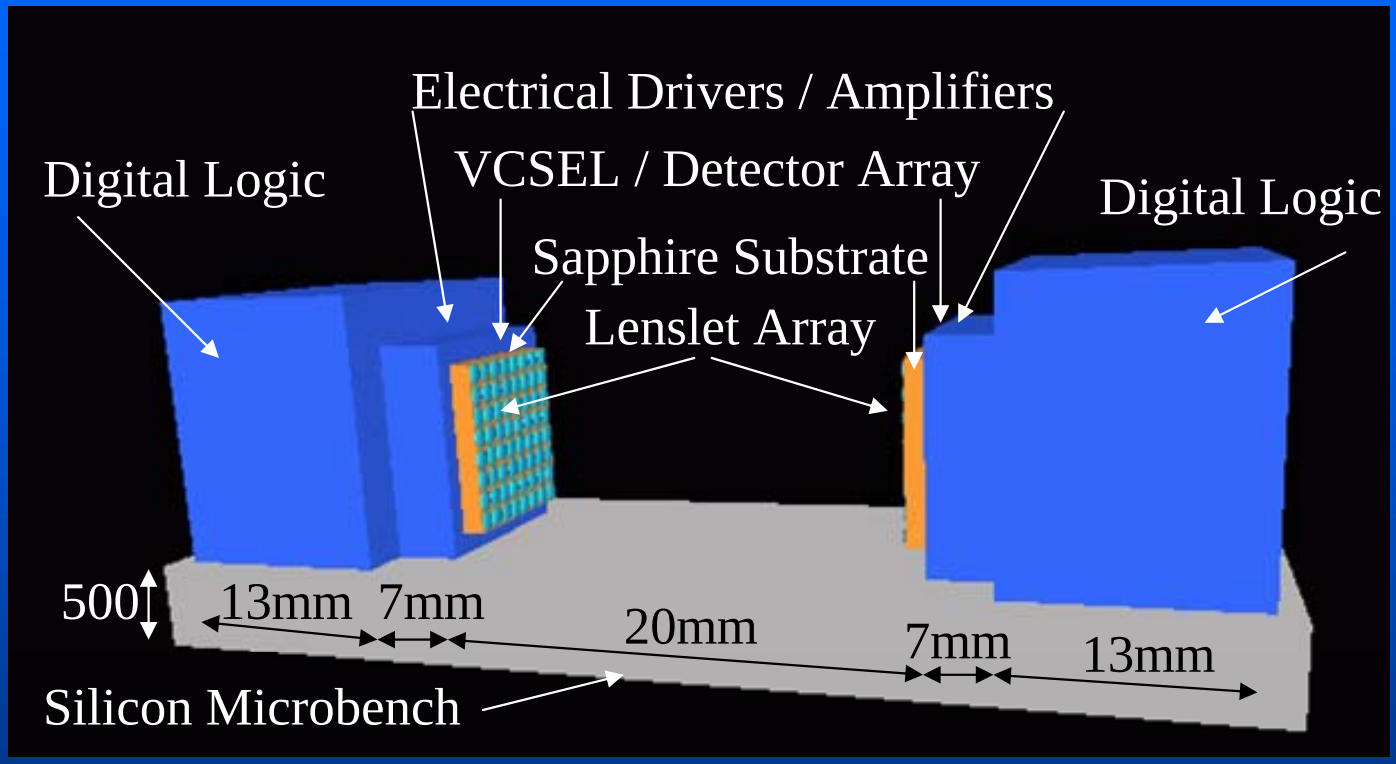
UCLA - Fresnel Lens
http://www.ee.ucla.edu/labs/laser/

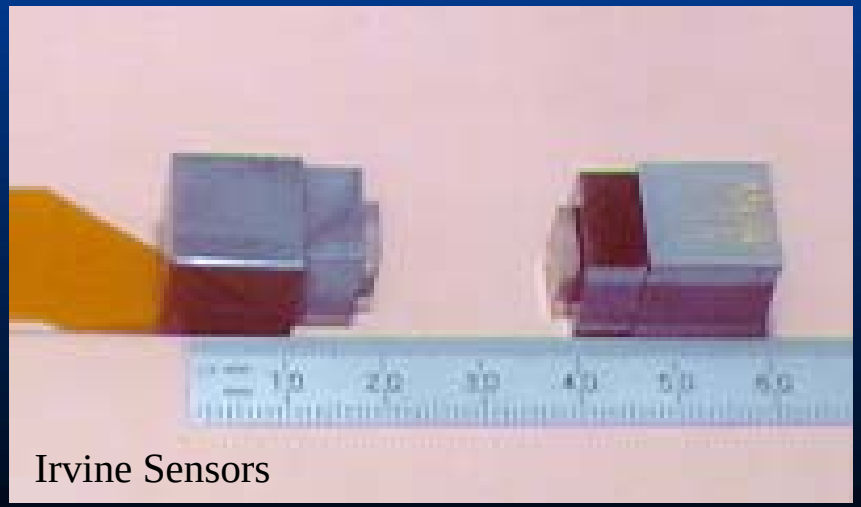


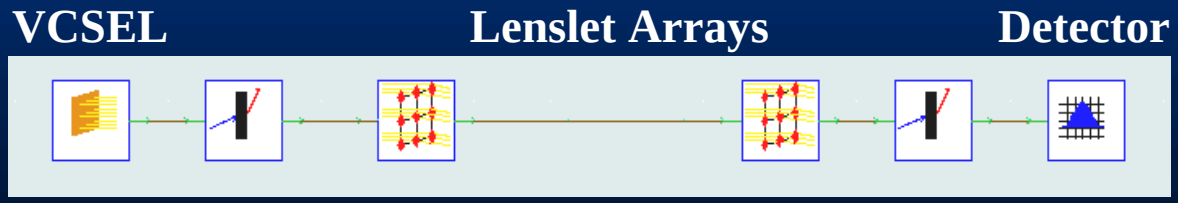
- Lens Efficiency - Approximately 10%
- 95% Gaussian Shape
- Results Compare with Motamdi et al.*

*Motamedi, M.E., Wu, M.C., Pister, K.S.J., "Micro-opto-mechanical devices and on-chip optical processing," Optical Engineering, Vol. 36, No. 5, May 1997, pp. 1282-1297.

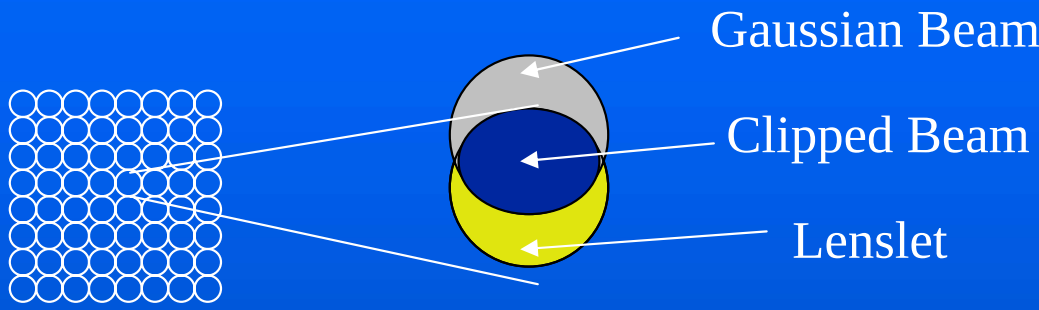
3D OESP / FFT Design



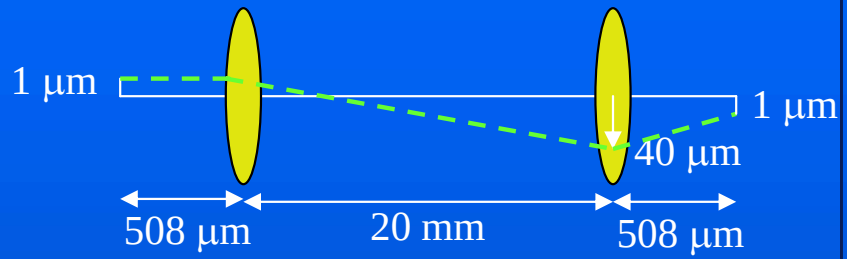

Irvine Sensors



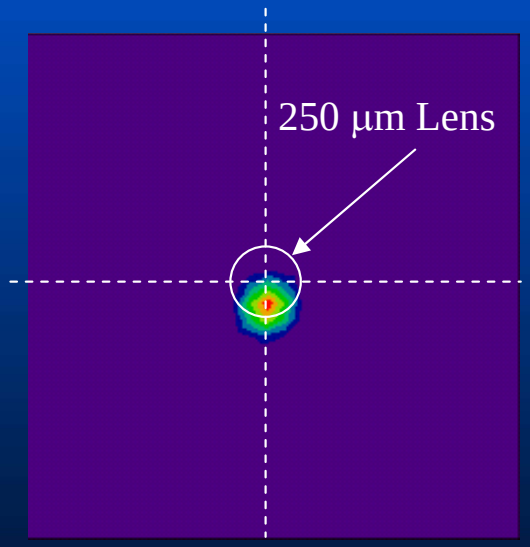
VCSEL 1 μm Mechanical Tolerancing - Scalar Analysis



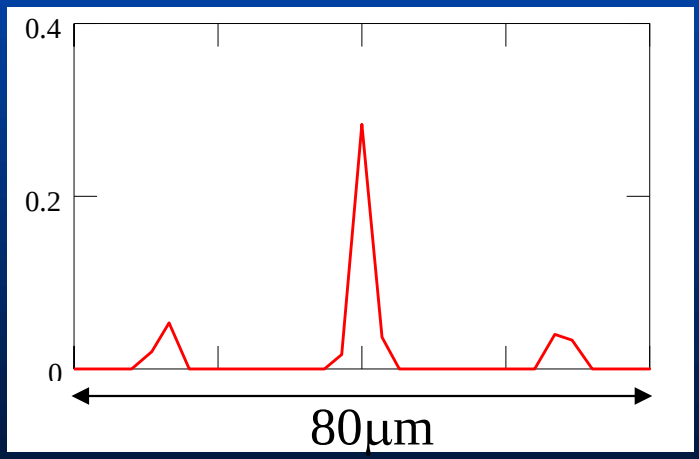
1 Lenslet of 8x8 Array



Power Loss	1st Lenslet	2nd Lenslet	Total Loss
1 um Offset	4.54%	22.60%	26.10%
No Offset	4.54%	0.00%	4.54%



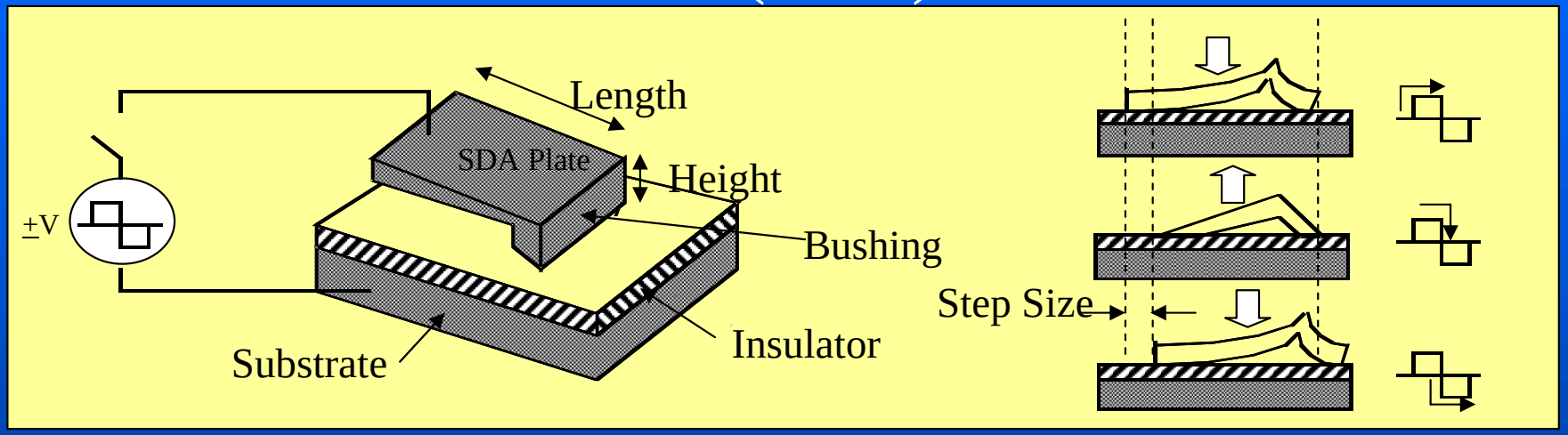
Intensity Distribution Contour
At 2nd Lenslet Plane



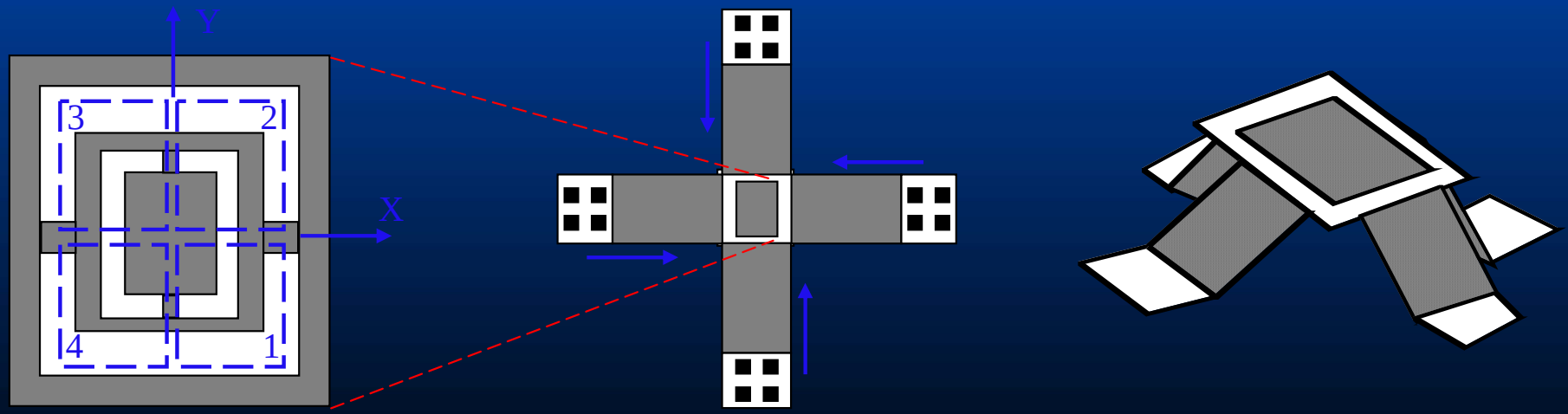
Final Intensity Distribution on
the 80μm detector

Optical MEM Modeling

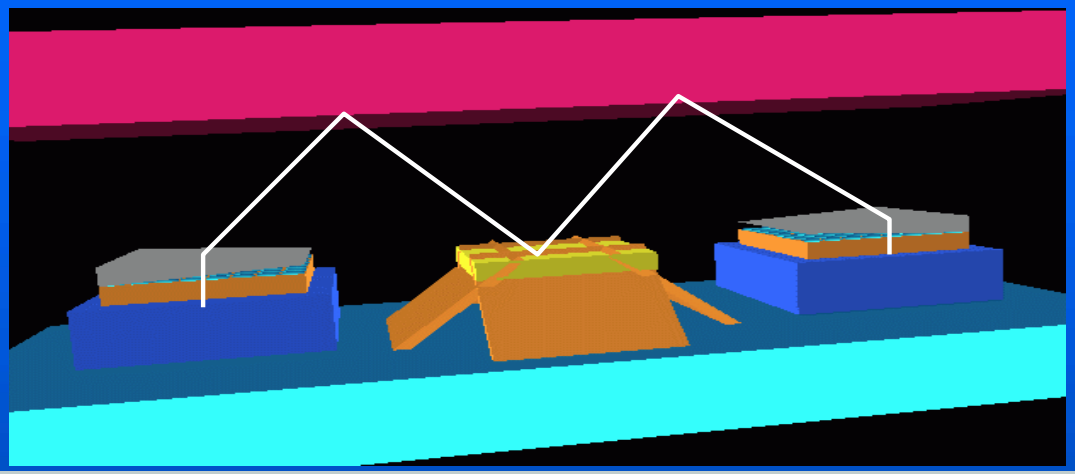
- Scratch Drive Acuator (SDA)

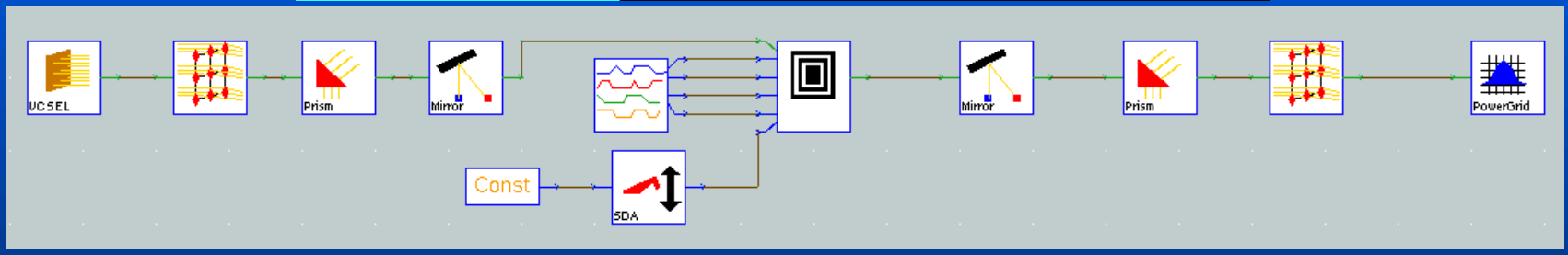


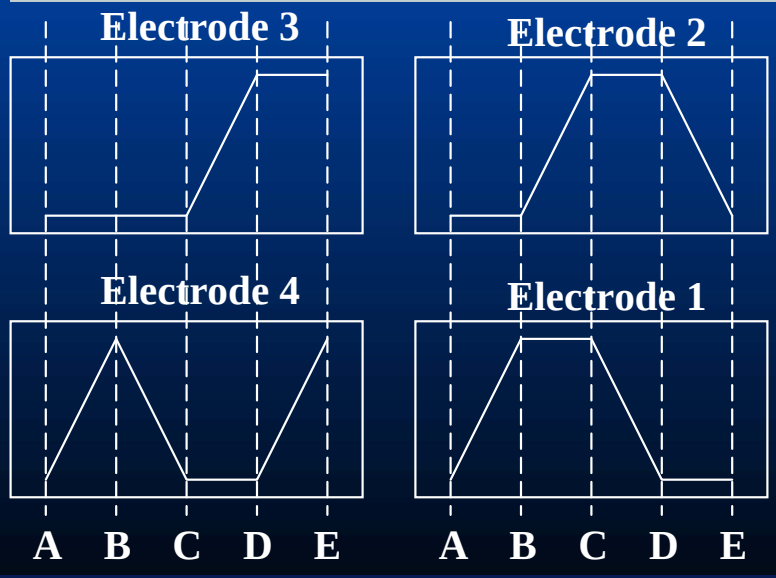
- Scanning Mirror on MESA Structure

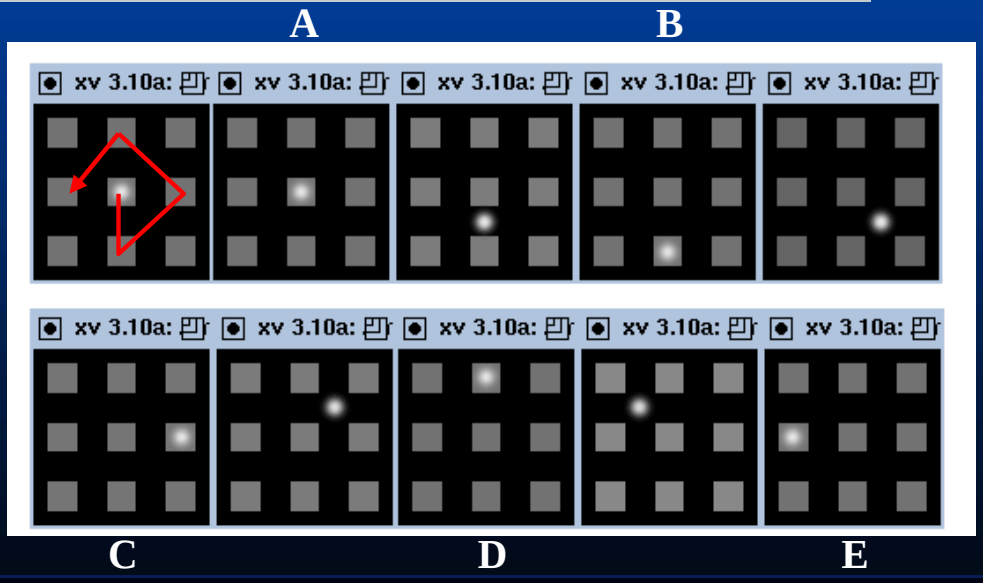


Beam Steering with Scanning Mirror

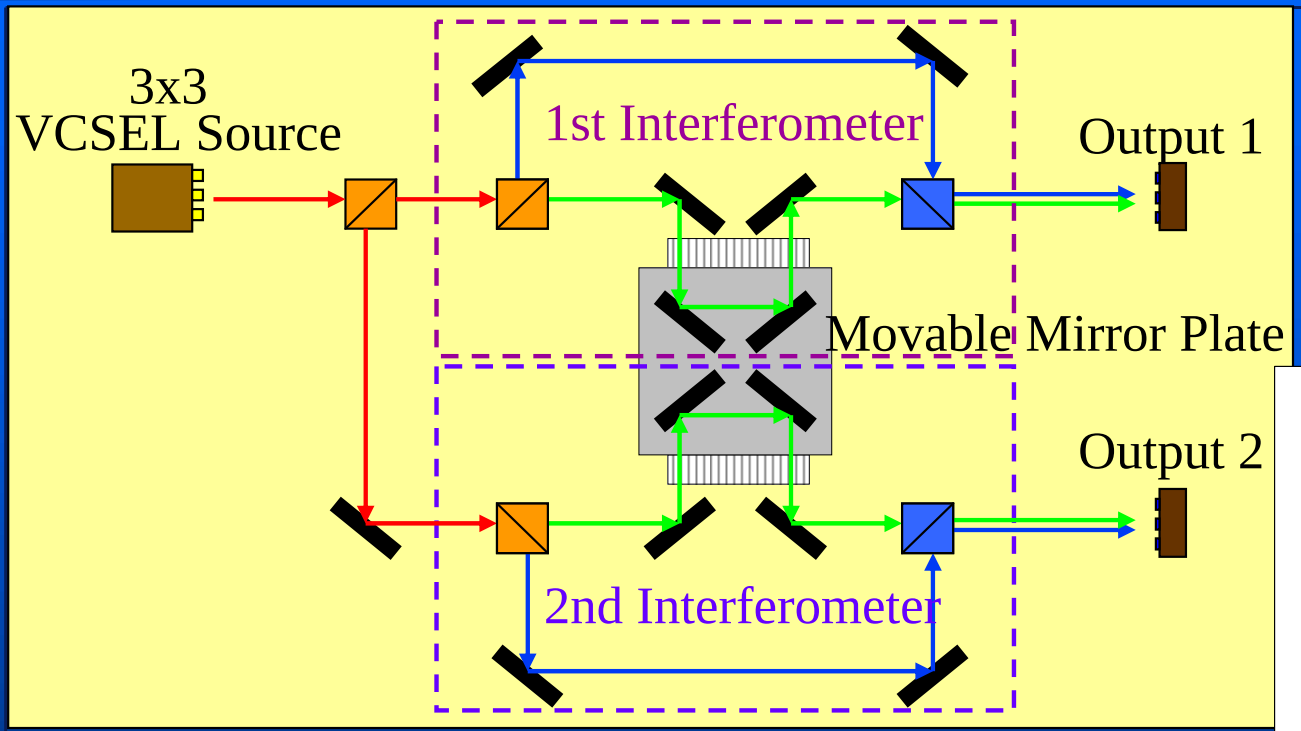




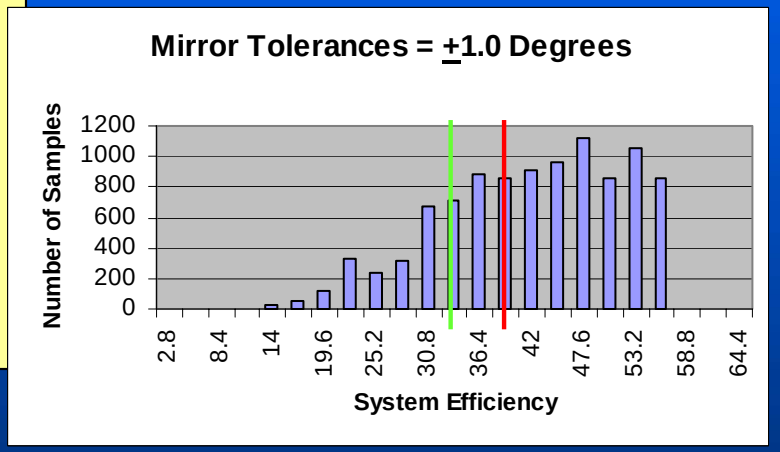


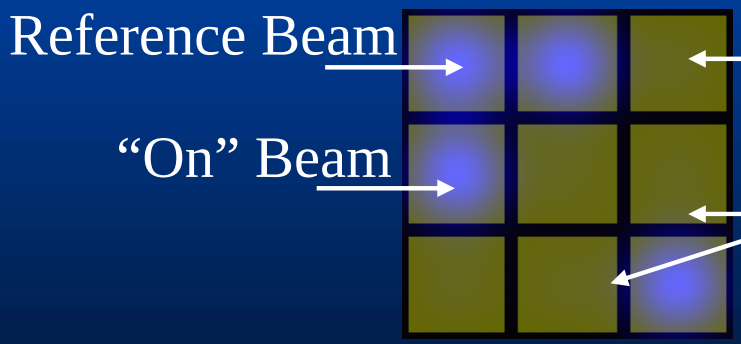


Modeling a 1x2 Optical MEM Switch

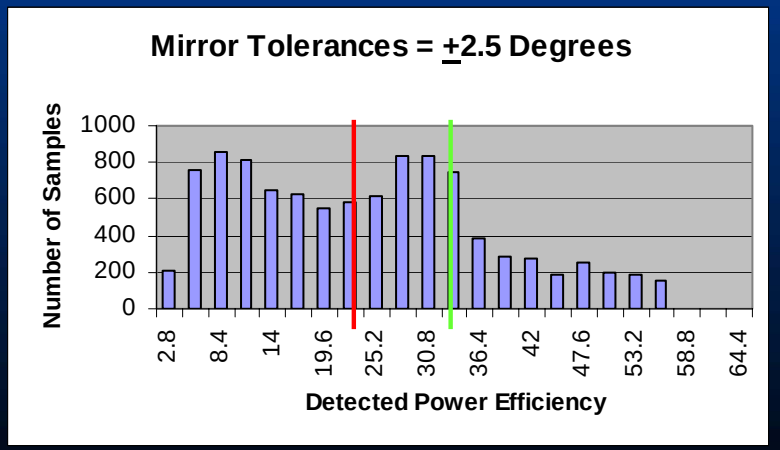


- Monte Carlo Analysis
  - Average efficiency
  - 33% efficiency

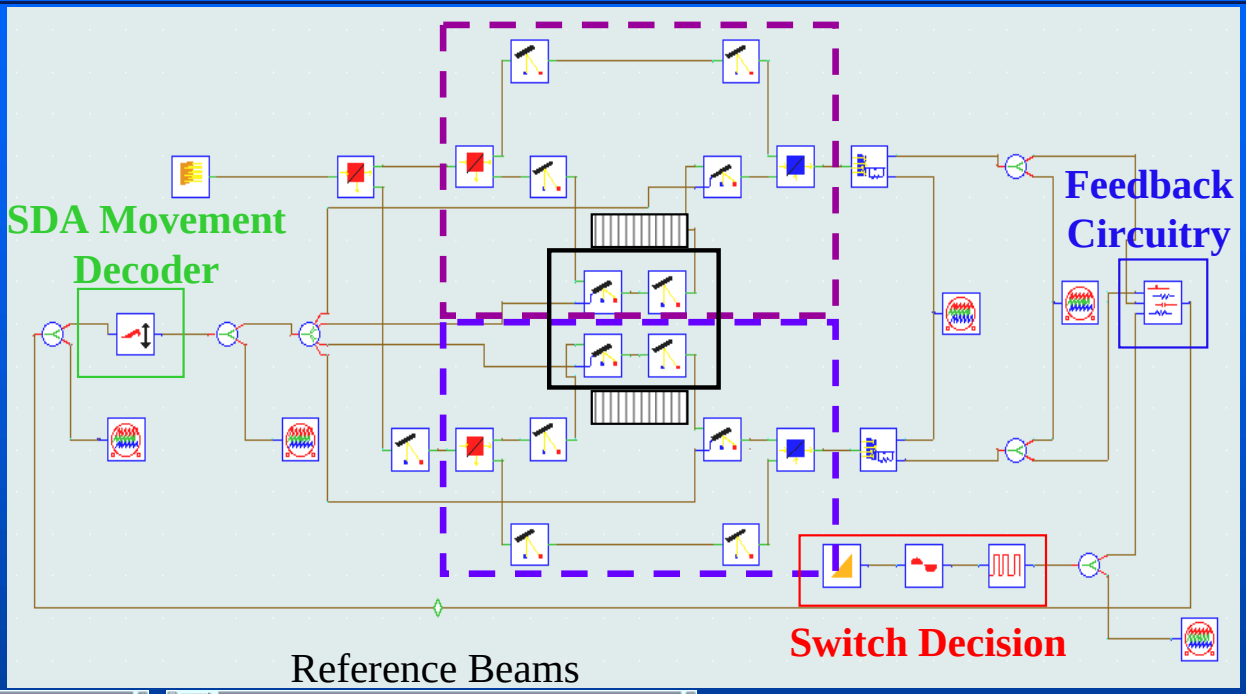




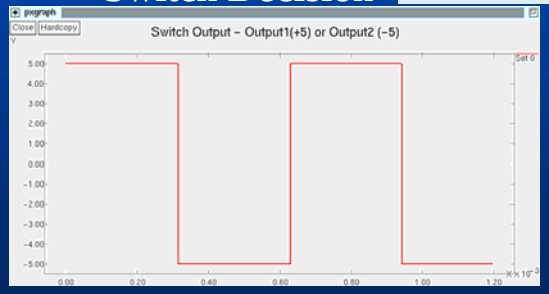
- 56% efficiency
- -15.5 dB worst case neighboring crosstalk



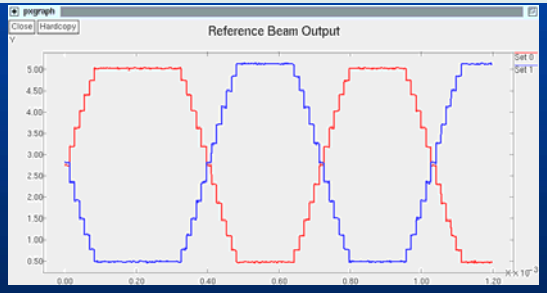
1x2 Dynamic Switch Response



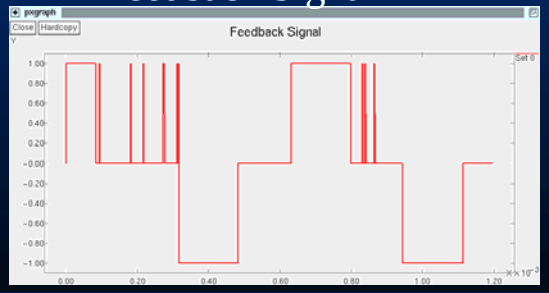
Switch Decision



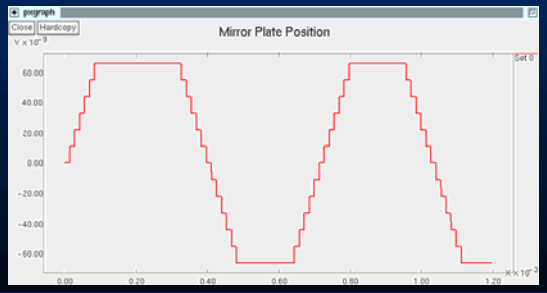
Reference Beams



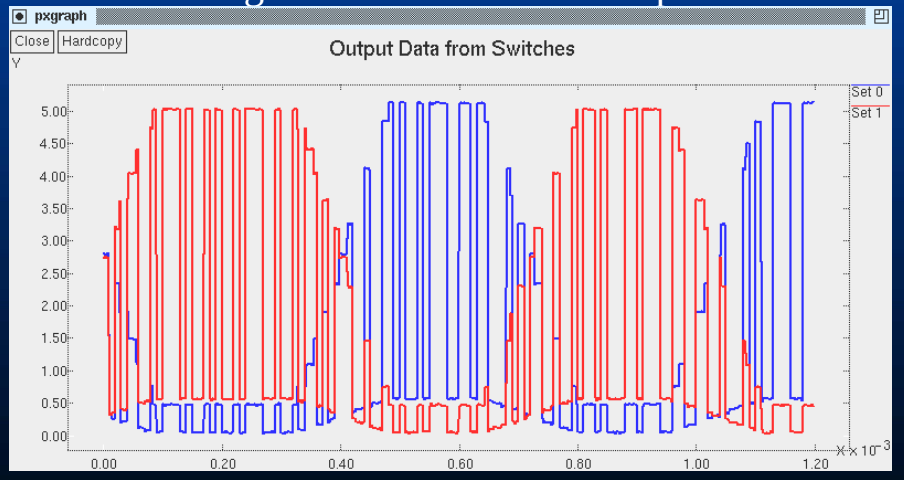
Feedback Signal



Mirror Plate Movement



Single Bit Data on Both Outputs



Conclusions

- Mixed technology CAD is needed for optical micro-systems & optical MEMS
- Chatoyant can be extended to model, simulate, and analyze optical micro-systems and optical MEMS
- Chatoyant advantages:
  - performs trade-offs
  - quick efficient analysis
  - reduce costly prototyping
- Porting Chatoyant to Windows NT
- For more information: http://kona.ee.pitt.edu/pittcad
- Contact: tim@ee.pitt.edu, steve@ee.pitt.edu