

Wavelength Sensitive Photonic Modules for Signal Conditioning

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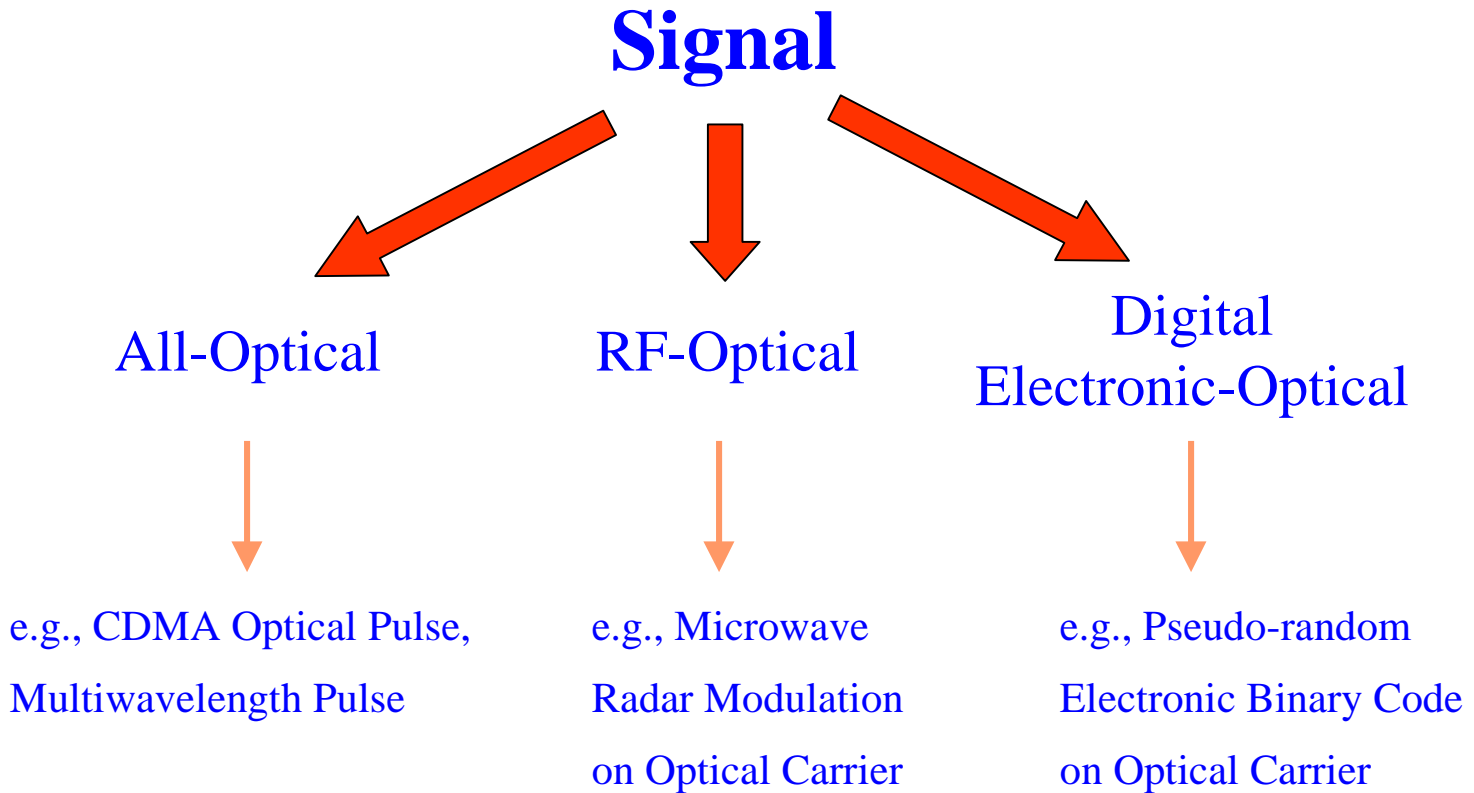
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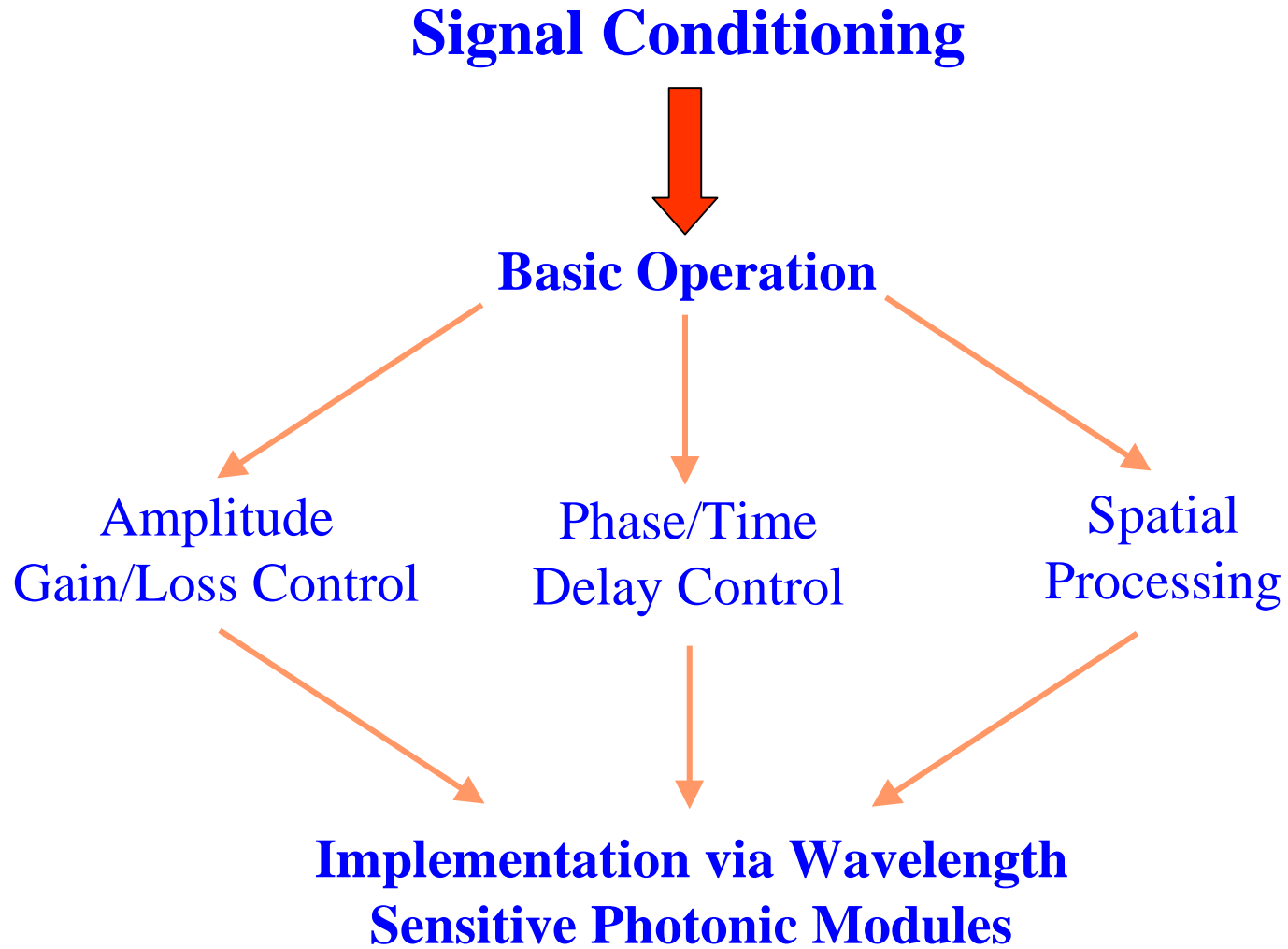
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Advantages of Wavelength Sensitive Photonic Modules

- Reduction in Hardware Complexity
- Enhancement in Signal Conditioning/Processing Power
- Multi-function Distributed Network Capacity
- Flexible Secure Communications

Applications of Our Wavelength Sensitive Photonic Modules

Wavelength Sensitive Photonic Modules

Phased Array Radars



- **Beamformers**
- **Transversal Filters**

Secure Communications



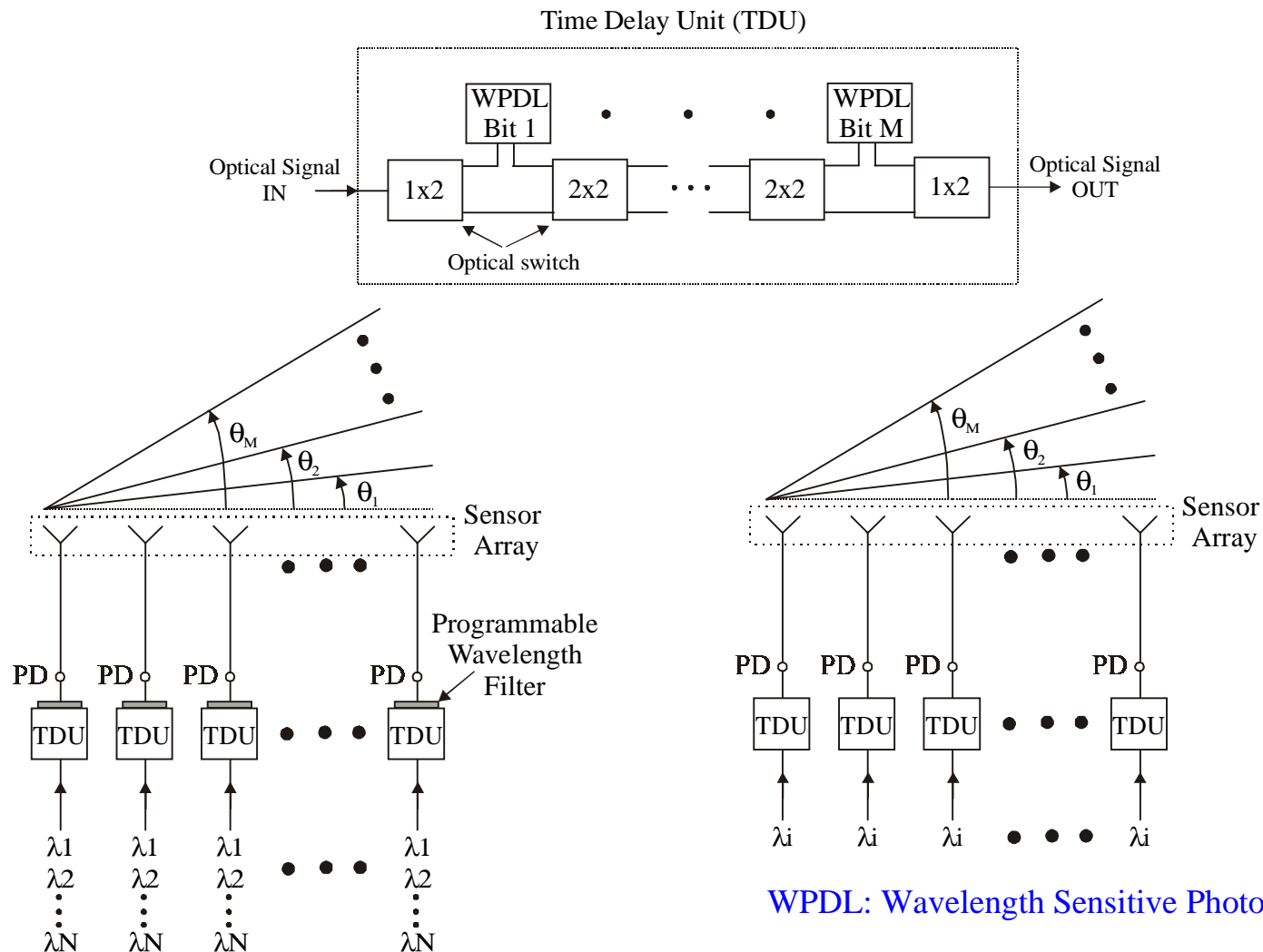
- **Pulse Shapers**
- **Space-Time CDMA**

Parallel Computing



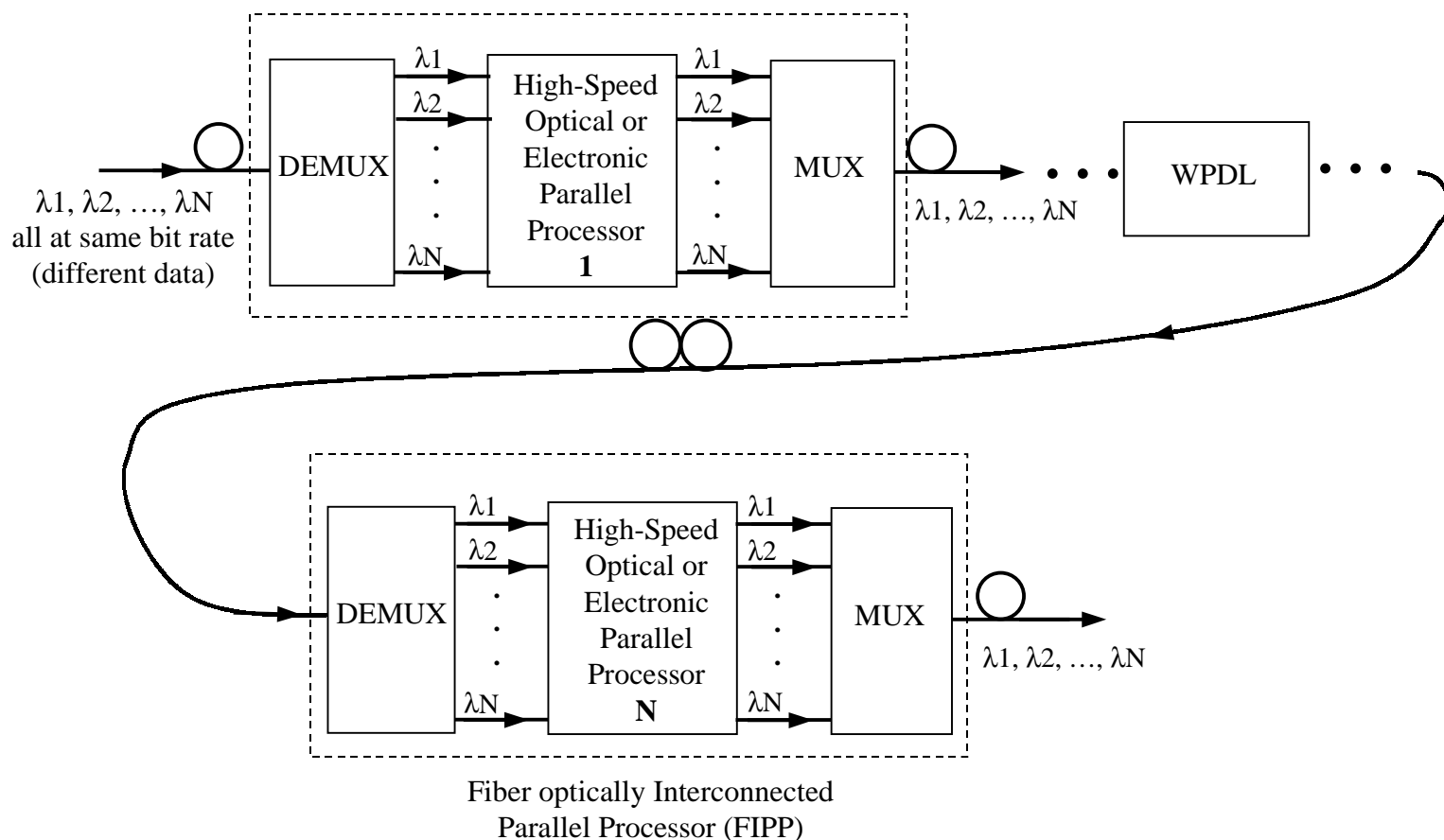
- **Parallel Processors**
- **A/D Converters**

Photonic Beamforming for Phased Array Control



N. A. Riza and N. Madamopoulos, "Phased-array antenna, maximum-compression, reversible photonic beam former with ternary designs and multiple wavelengths," *Applied Optics*, V. 36, No. 5, pp. 983-996, Feb. 1997.

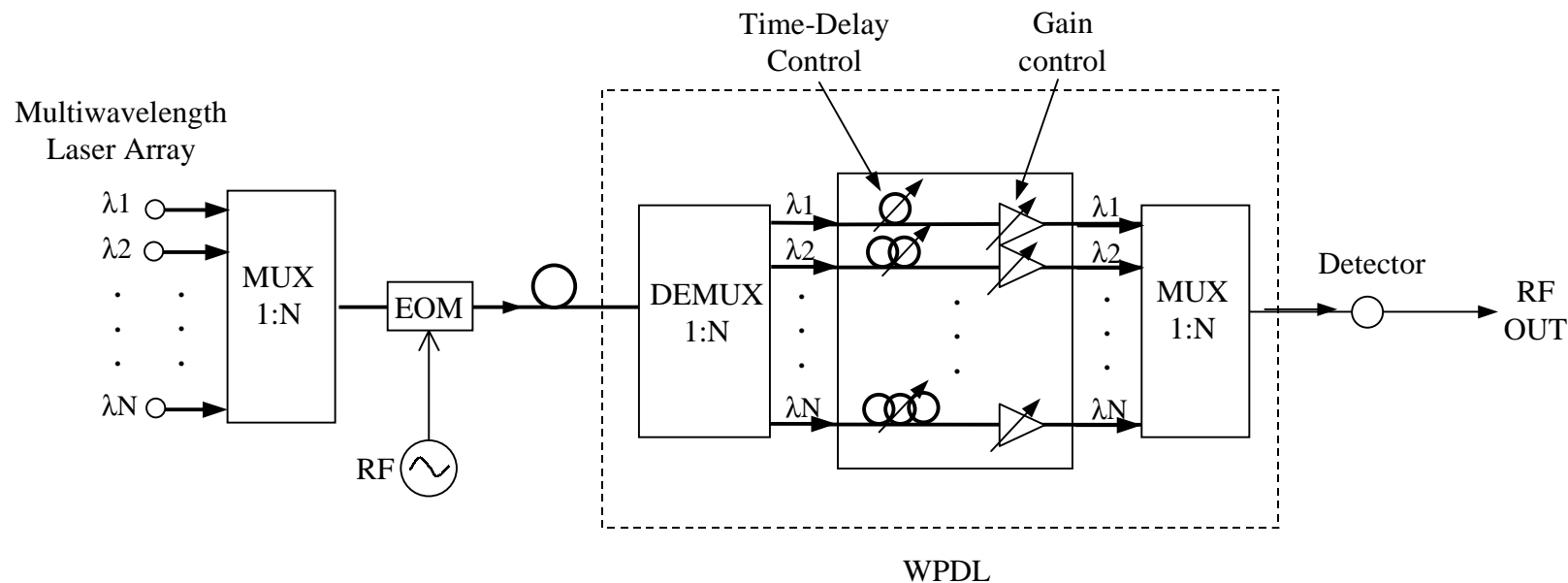
Timing Jitter Controls in High Speed Optical Interconnections and A-D Convertors



WPDL: Wavelength Sensitive Photonic Delay Line

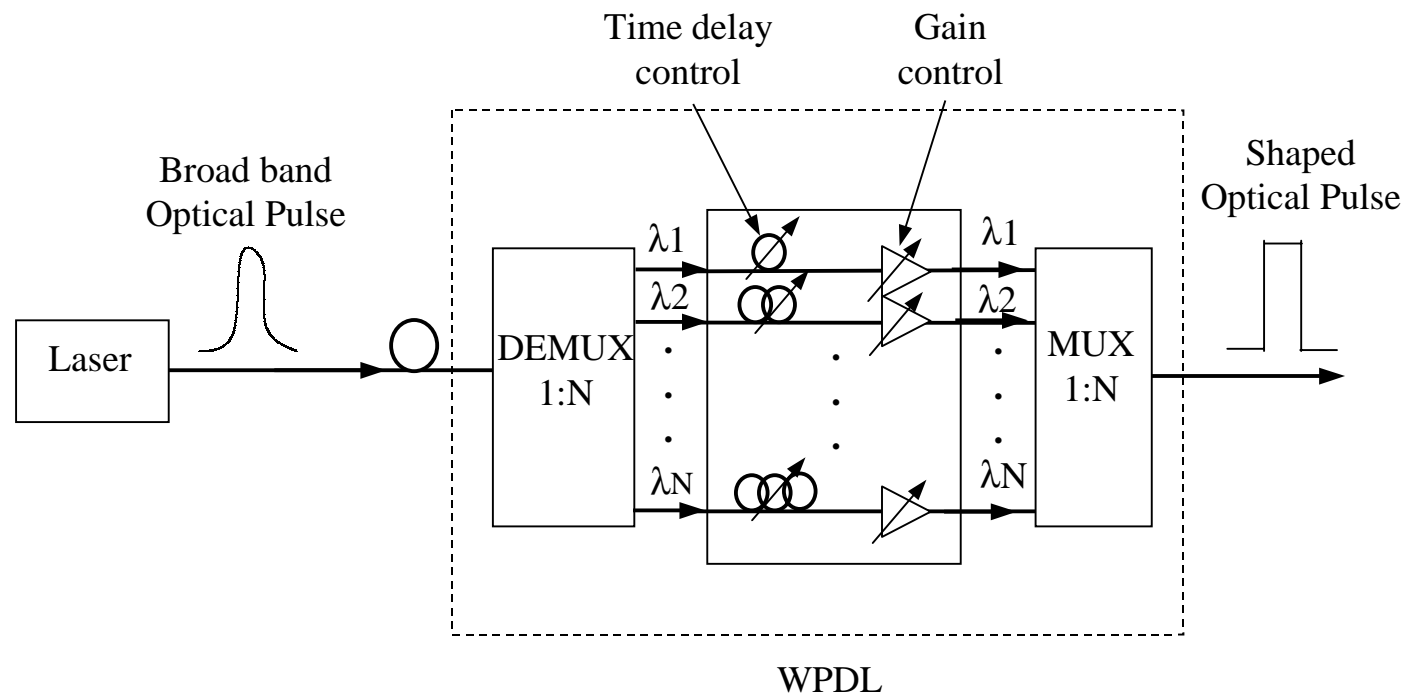
N. A. Riza and S. Sumriddetchkajorn, "Micromechanics-based wavelength sensitive photonic beam control architectures and applications," *Applied Optics*, V. 39, No. 6, pp. 919-932, Feb. 2000.

Basic Block Diagram of a RF Transversal Filter Architecture



N. A. Riza and S. Sumriddetchkajorn, "Micromechanics-based wavelength sensitive photonic beam control architectures and applications," *Applied Optics*, V. 39, No. 6, pp. 919-932, Feb. 2000.

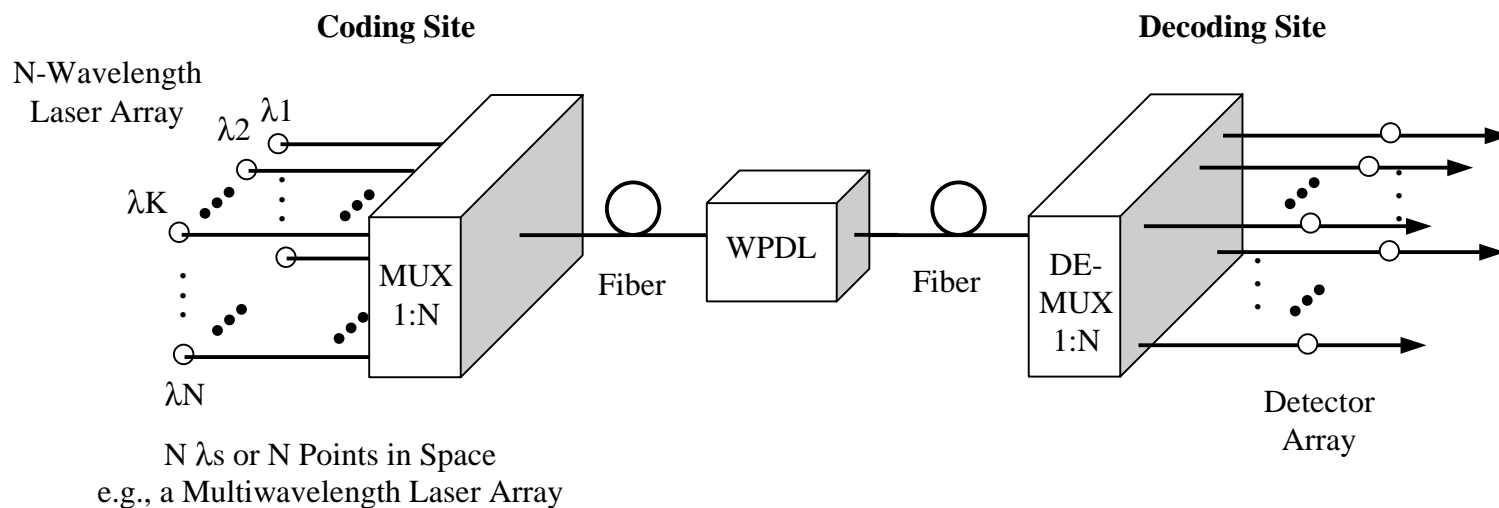
Dispersion Compensation and Equalization in Ultrafast WDM Links



WPDL: Wavelength Sensitive Photonic Delay Line

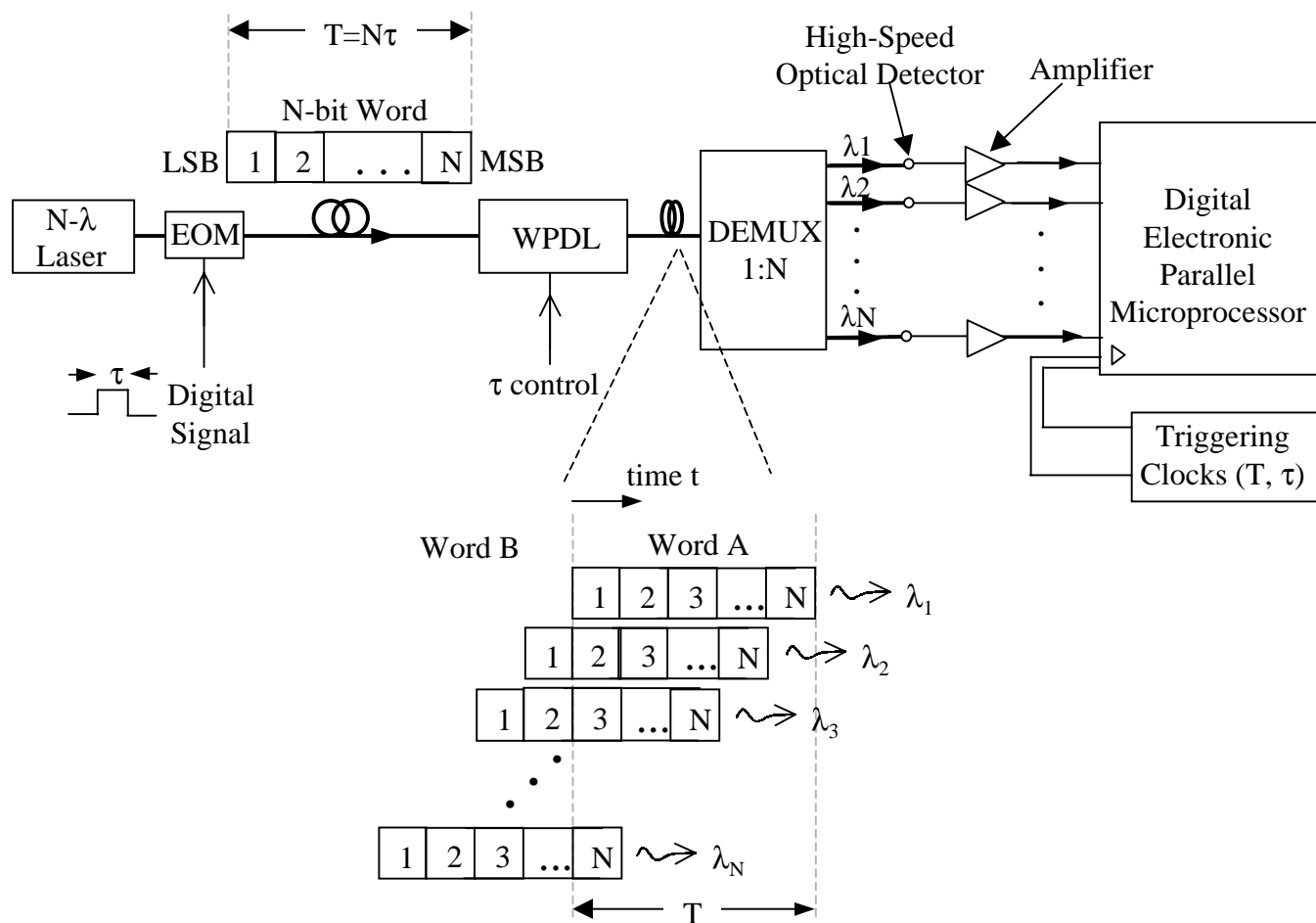
N. A. Riza and S. Sumriddetchkajorn, "Micromechanics-based wavelength sensitive photonic beam control architectures and applications," *Applied Optics*, V. 39, No. 6, pp. 919-932, Feb. 2000.

Space-Time WDM Optical CDMA Link Structure



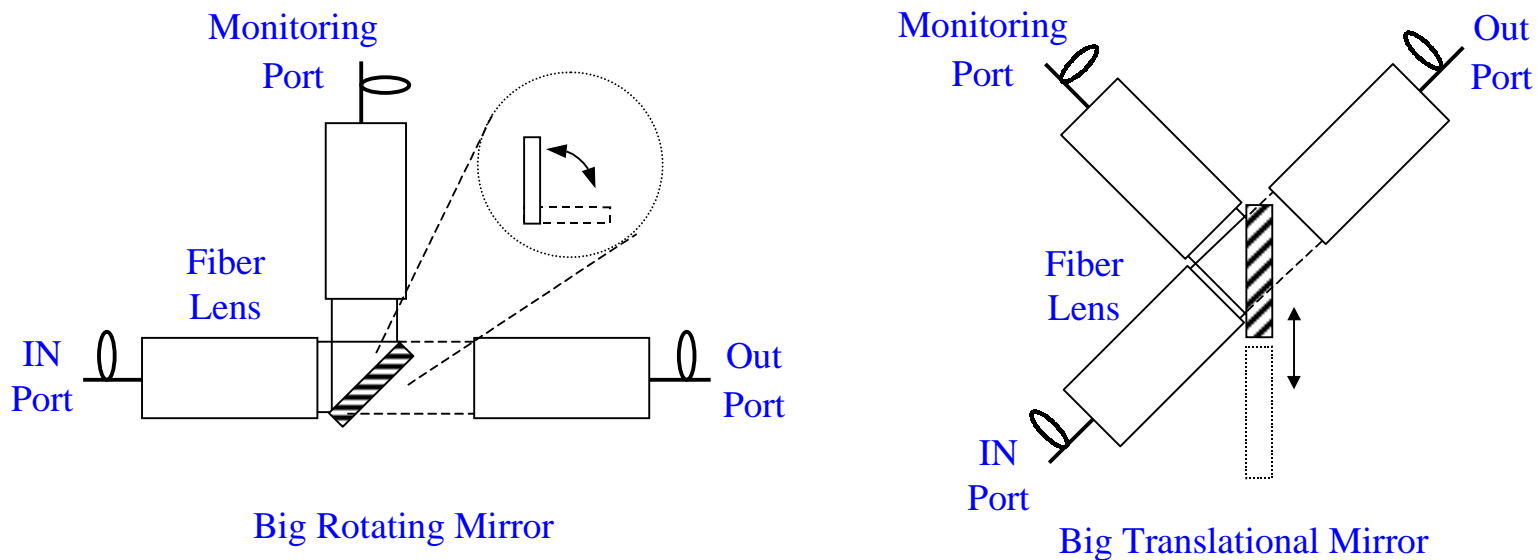
N. A. Riza and S. Sumriddetchkajorn, "Micromechanics-based wavelength sensitive photonic beam control architectures and applications," *Applied Optics*, V. 39, No. 6, pp. 919-932, Feb. 2000.

Basic Block Diagram of the Photonic Bit Serial-to-Parallel Word Converter



N. A. Riza and S. Sumriddetchkajorn, "Micromechanics-based wavelength sensitive photonic beam control architectures and applications," *Applied Optics*, V. 39, No. 6, pp. 919-932, Feb. 2000.

Non-Robust Approaches to make a Variable Fiber-Optic Attenuator



Large micromirror sizes → Slow Response Speed

Solution for Faster Speed

→ Use One Small Micromirror

Problems

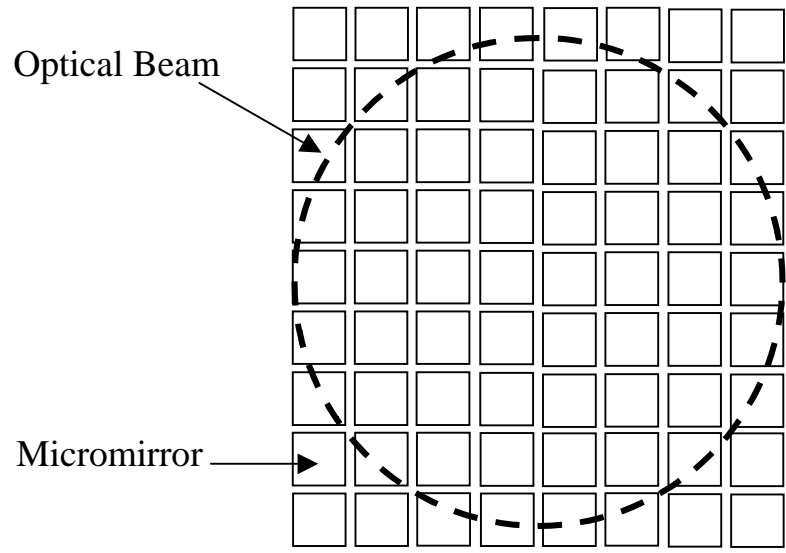
- Alignment Sensitivity
- Catastrophic Failure

Design Dilemma

Alignment Sensitivity  vs  Speed

One Mirror  Catastrophic Attenuator Malfunction

Solution



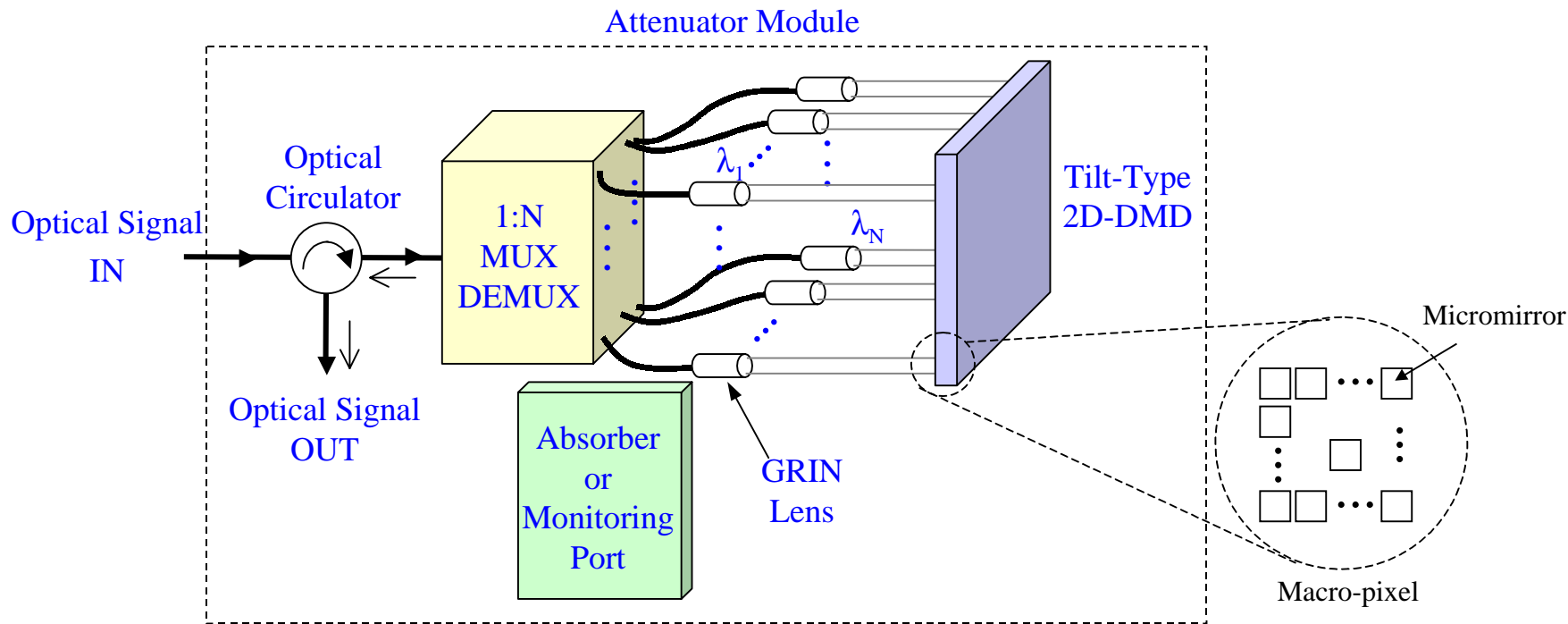
Use a Macro-pixel



Fault Tolerance and High Speed

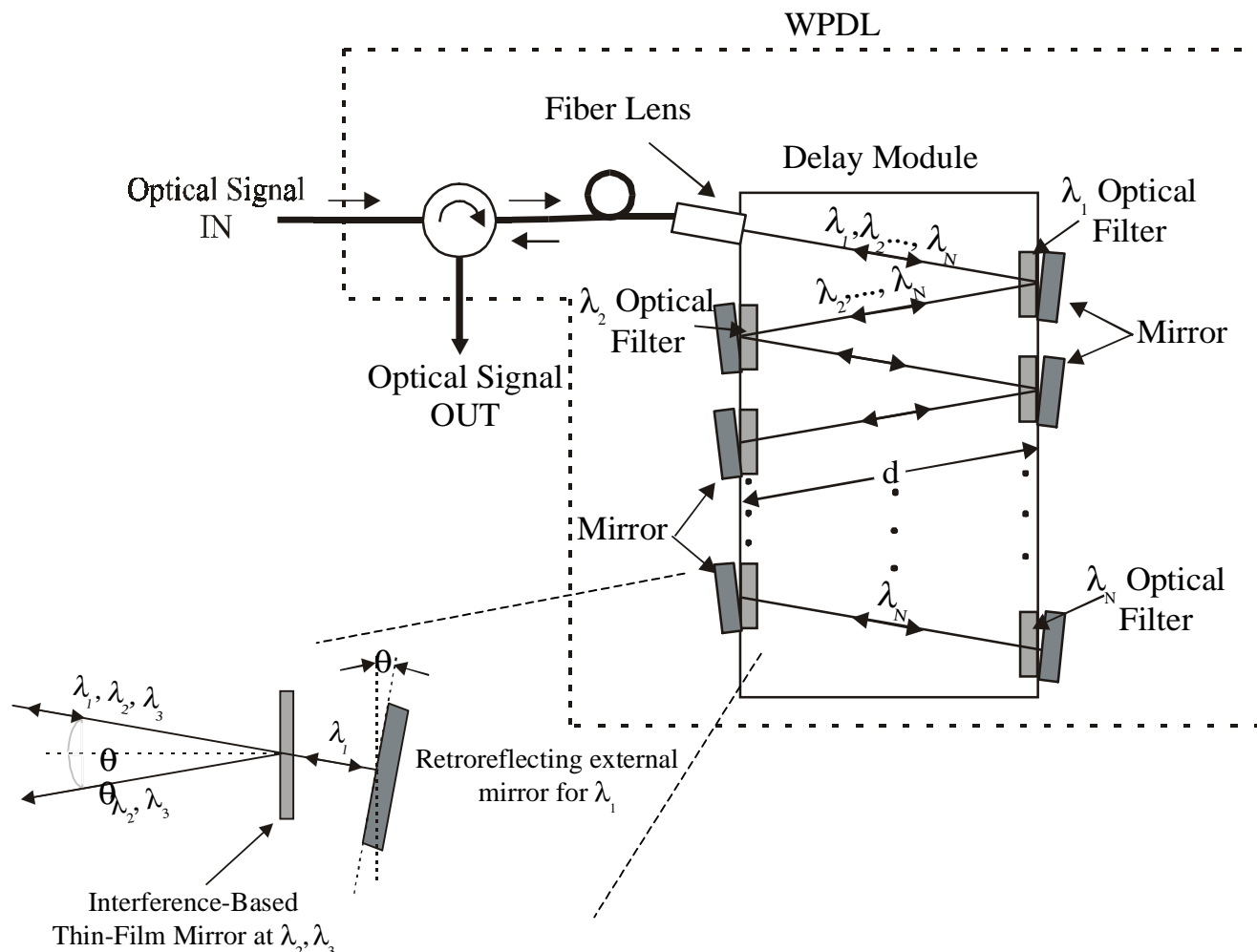
Ref: N. A. Riza and S. Sumriddetchkajorn, "Fault tolerant dense multiwavelength add-drop filter with a two dimensional digital micromirror device," *Applied Optics*, Vol. 37, No. 27, pp. 6355-6361, September, 1998.

Retro-Reflective Multi-Wavelength Programmable Fiber-Optic Attenuator using Small Tilt Digital Micromirror



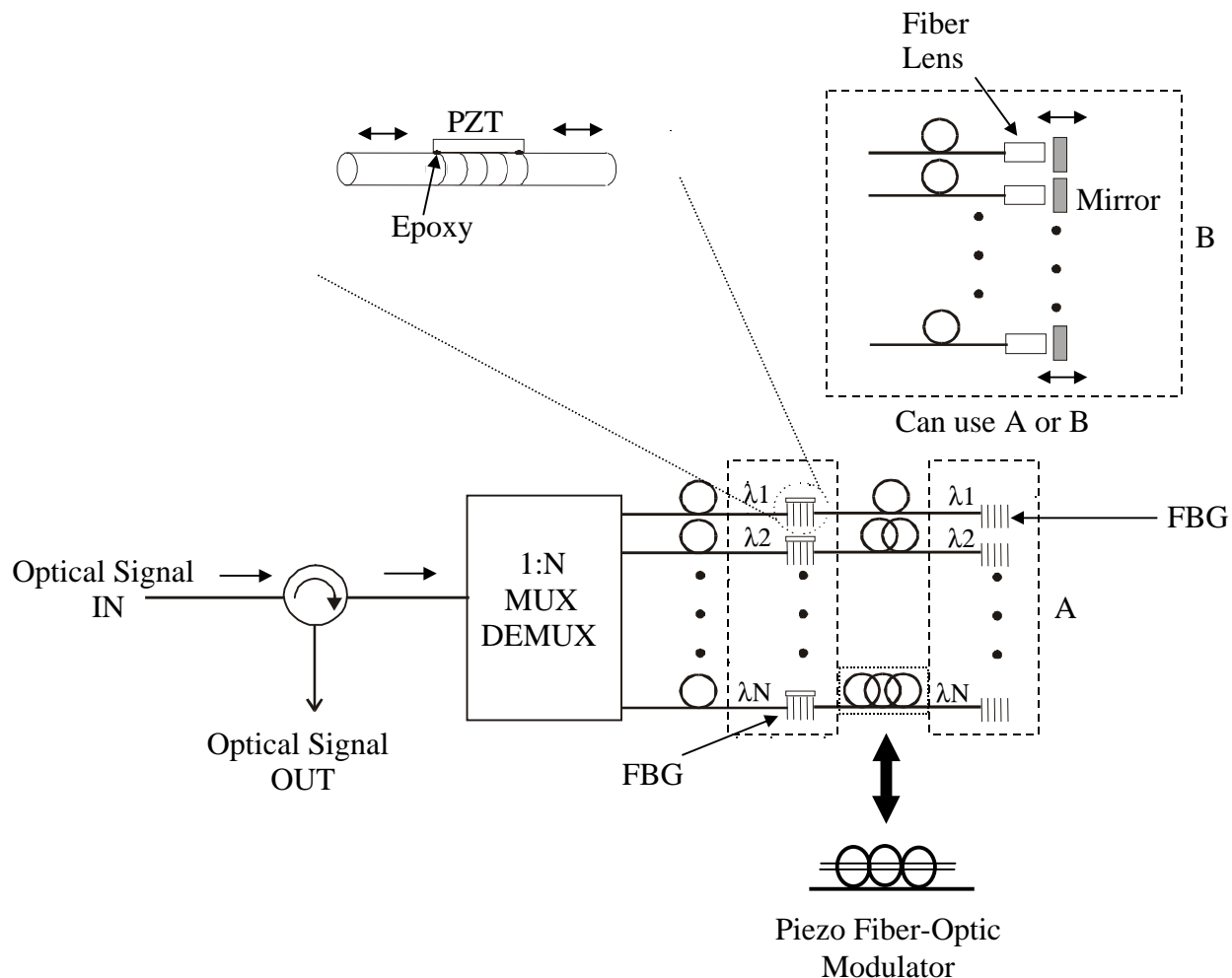
N. A. Riza and S. Sumriddetchkajorn, "Digitally controlled fault-tolerant multiwavelength programmable fiber-optic attenuator using a two dimensional digital micromirror device," *Optics Letters*, Vol. 24, No. 5, pp. 282-284, March 1, 1999.

Our Proposed Basic Wavelength Sensitive Photonic Delay Line (WPDFL) Architecture



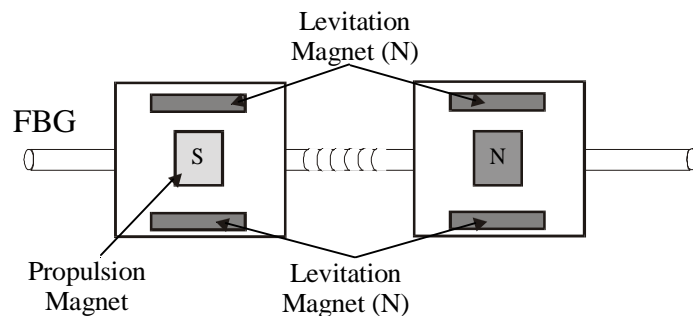
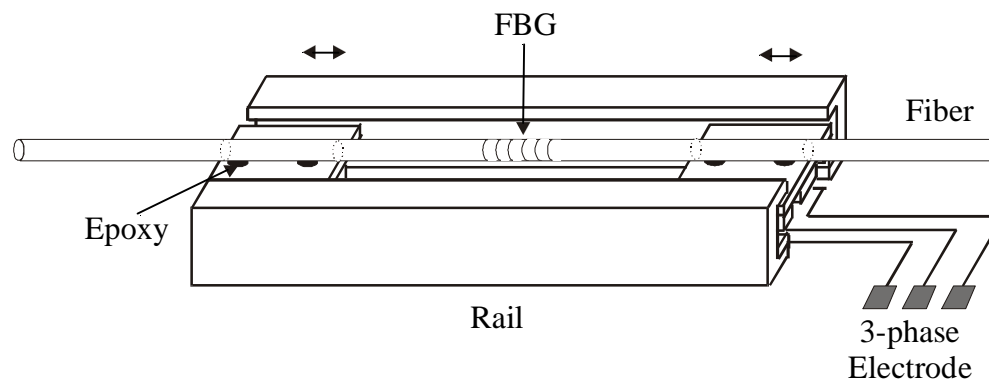
N. A. Riza and S. Sumriddetchkajorn, "Micromechanics-based wavelength sensitive photonic beam control architectures and applications," *Applied Optics*, V. 39, No. 6, pp. 919-932, Feb. 2000.

Proposed Tunable WPDL Architecture using FBG-based Serial-Parallel Approach

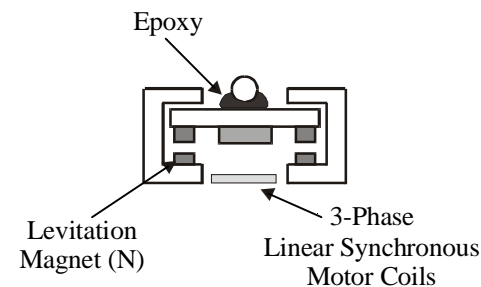


N. A. Riza and S. Sumriddetchkajorn, "Micromechanics-based wavelength sensitive photonic beam control architectures and applications," *Applied Optics*, V. 39, No. 6, pp. 919-932, Feb. 2000.

MEMS-based Fiber Bragg Grating Compressor using Magnetic Levitation (MAGLAV) and Propulsion Method



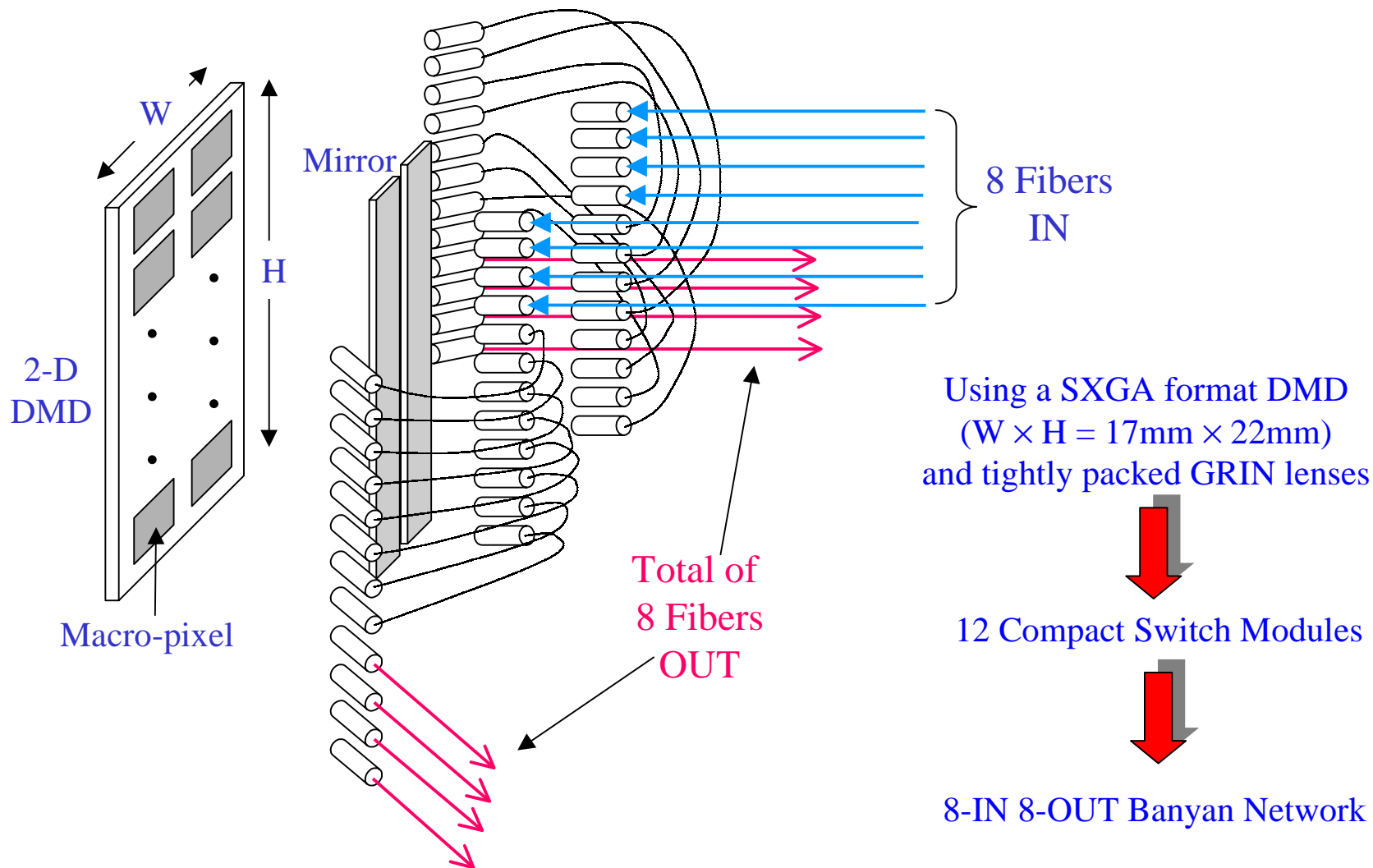
BOTTOM VIEW



SIDE VIEW

N. A. Riza and S. Sumriddetchkajorn, "Micromechanics-based wavelength sensitive photonic beam control architectures and applications," *Applied Optics*, V. 39, No. 6, pp. 919-932, Feb. 2000.

8 × 8 3-D Switch Matrix Package



N. A. Riza and S. Sumriddetchkajorn, "Small tilt micromirror-based multiwavelength three-dimensional 2 x 2 fiber-optic switch structures," *Optical Engineering*, Vol. 39, No. 2, pp. 379-386, Feb. 2000.

Conclusion

- Introduced Powerful Wavelength Sensitive Photonic Modules and Applications
- Introduced Versatile Approach to MEMS-based Optical Component Design

Macro-pixel Approach



- Our Dual-Use Module Applications Include:

Military

- RF Signal Processing
- Phased Array Radars
- Secure Communication Systems

Commercial (Telecom.)

- WDM Add/Drop Filters
- Optical Crossconnects
- Variable Fiber-Optic Attenuators