A Compact Wavelength Selective 2x2 Fiber-Optic Switch

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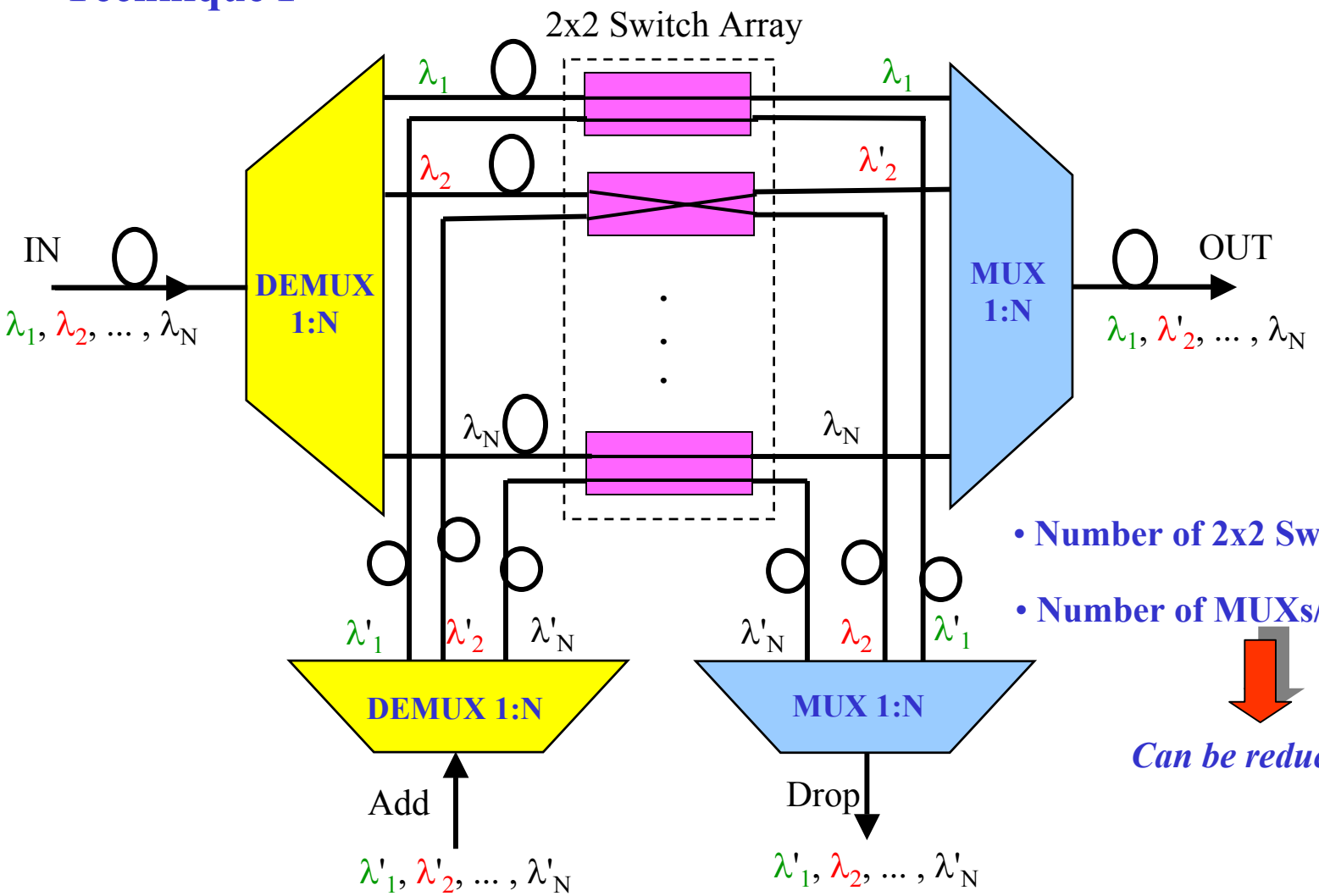
WDM Wavelength Router Structures

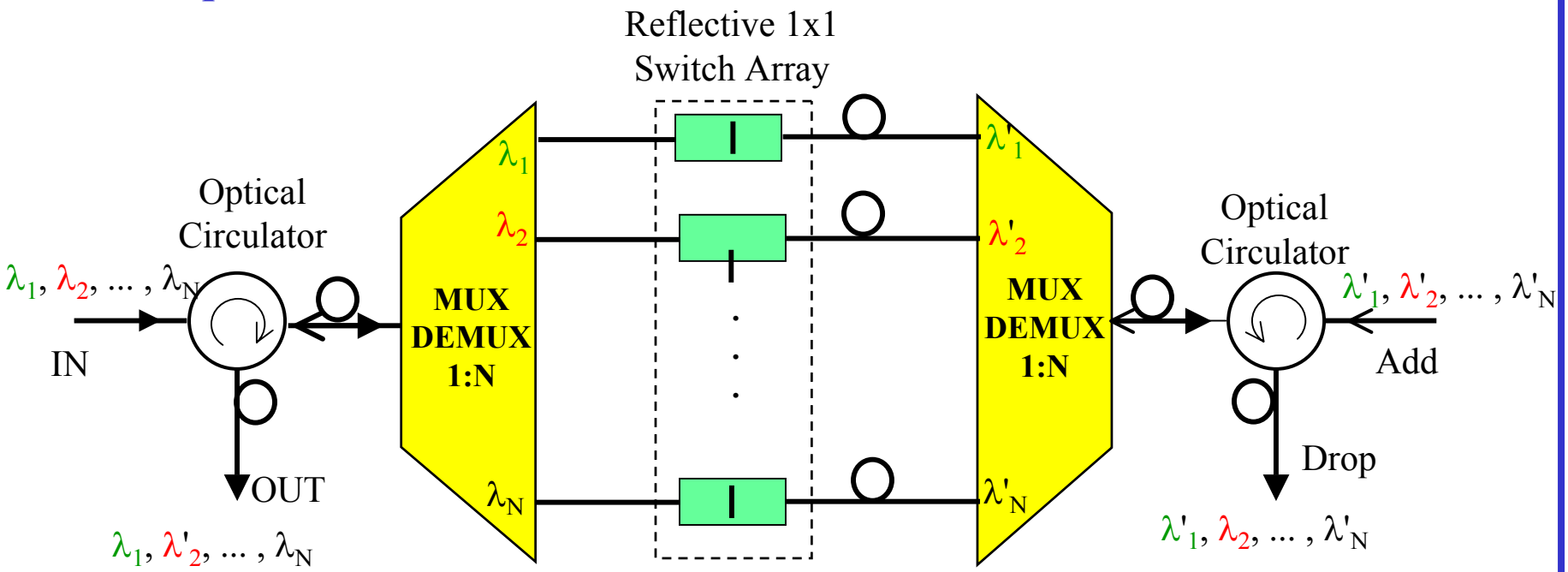
- **Technique I**



- **Number of 2x2 Switches = N**
- **Number of MUXs/DeMUXs = 4**

Can be reduced?

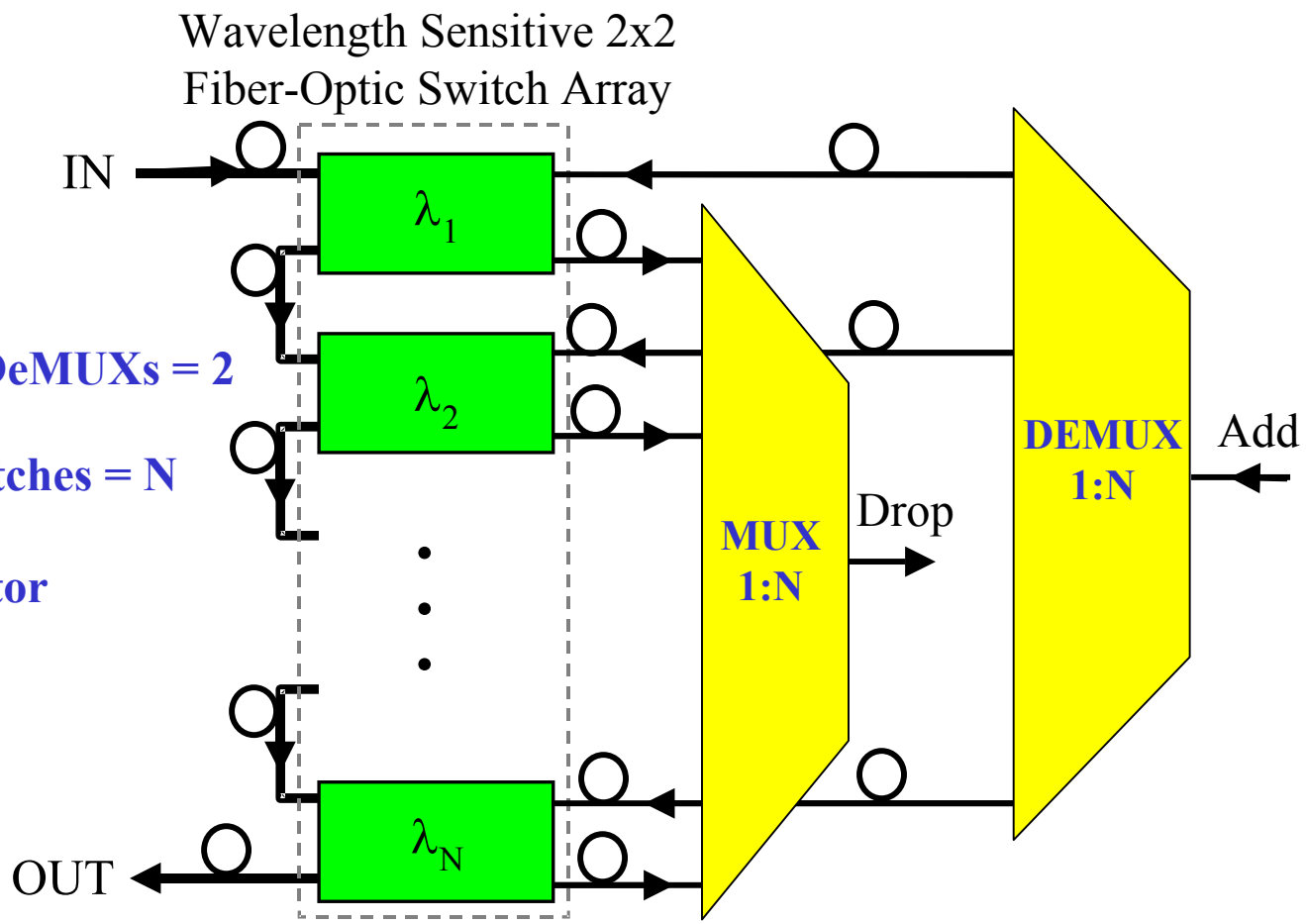
- **Technique II**



- **Number of MUXs/DeMUXs = 2**
- **Number of 1x1 Switches = N**
- **Number of Optical Circulators = 2** ⇒ ***Can be eliminated?***

Our WDM Routing Approach

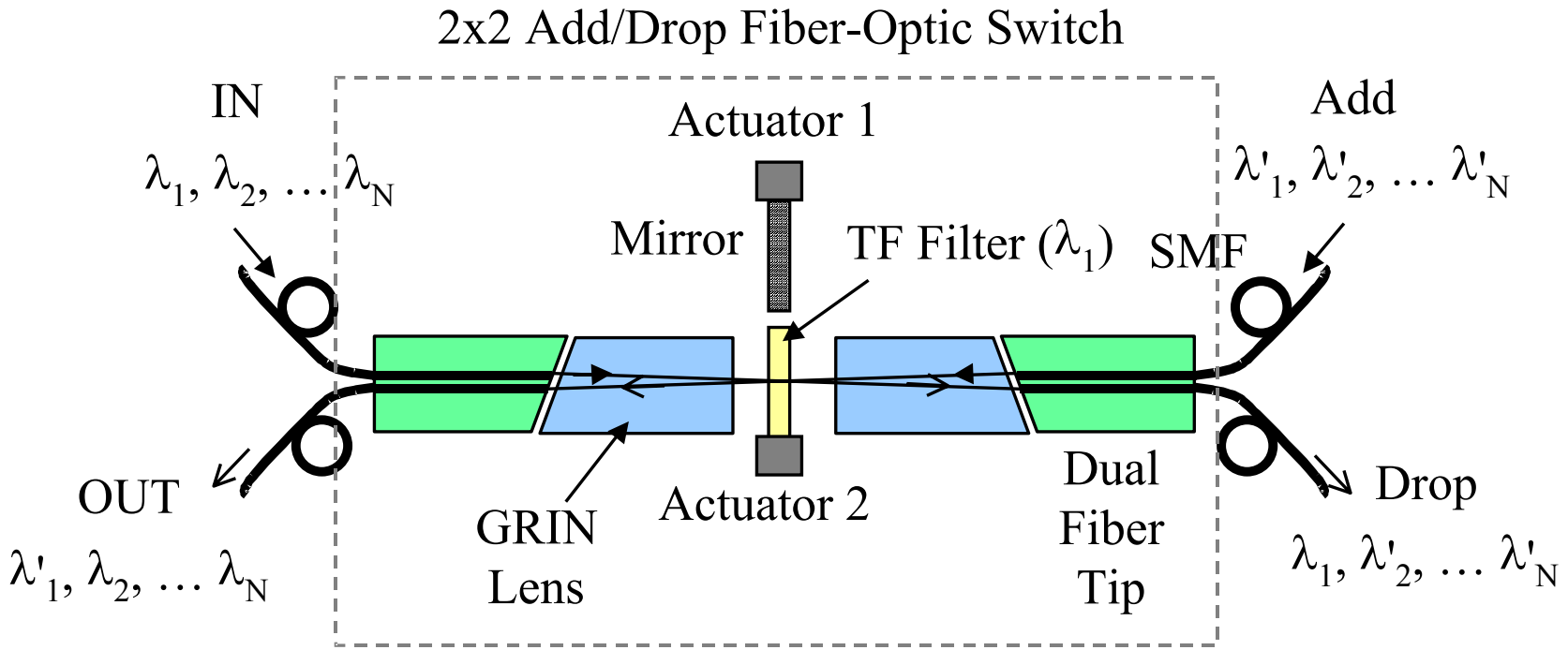
- Number of MUXs/DeMUXs = 2
- Number of 2x2 Switches = N
- No Optical Circulator



Motivation of Using Commercially Available Thin Film Filter

- Low Cost Device
- Low Optical Loss
- Low Polarization Dependent Loss
- Low Polarization Mode Dispersion
- Moderate Optical Isolation
- High Durability

Our Proposed Low Cost Reconfigurable Thin Film Filter-based 2x2 Add/Drop Fiber-Optic Switch Structure



Independent Control of Mirror and Thin Film Filter

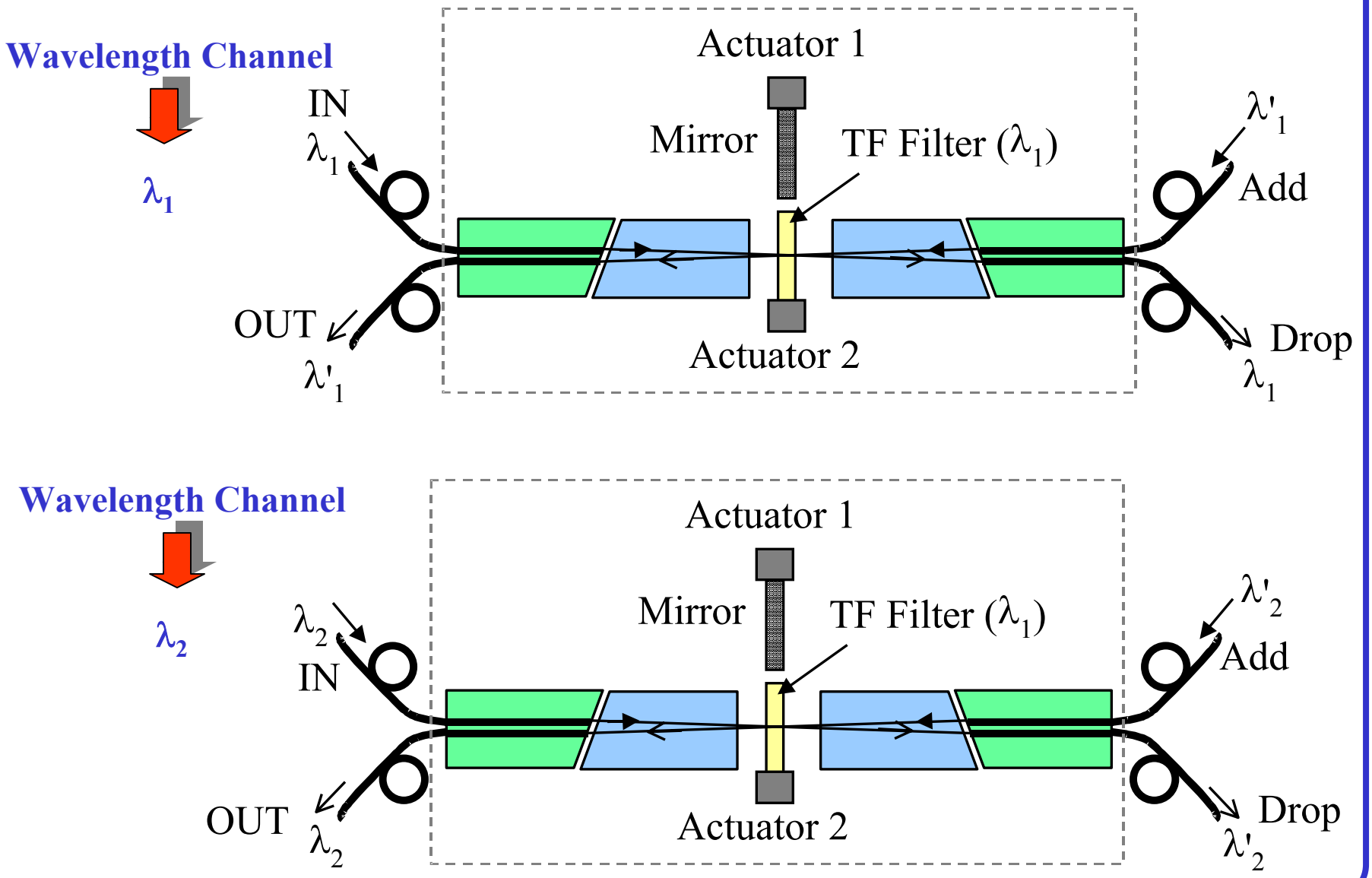
Leads

- Ease of Free Space Optical Alignment
- Response Time ≃ Speed of Mechanical Optical Switch in the Market

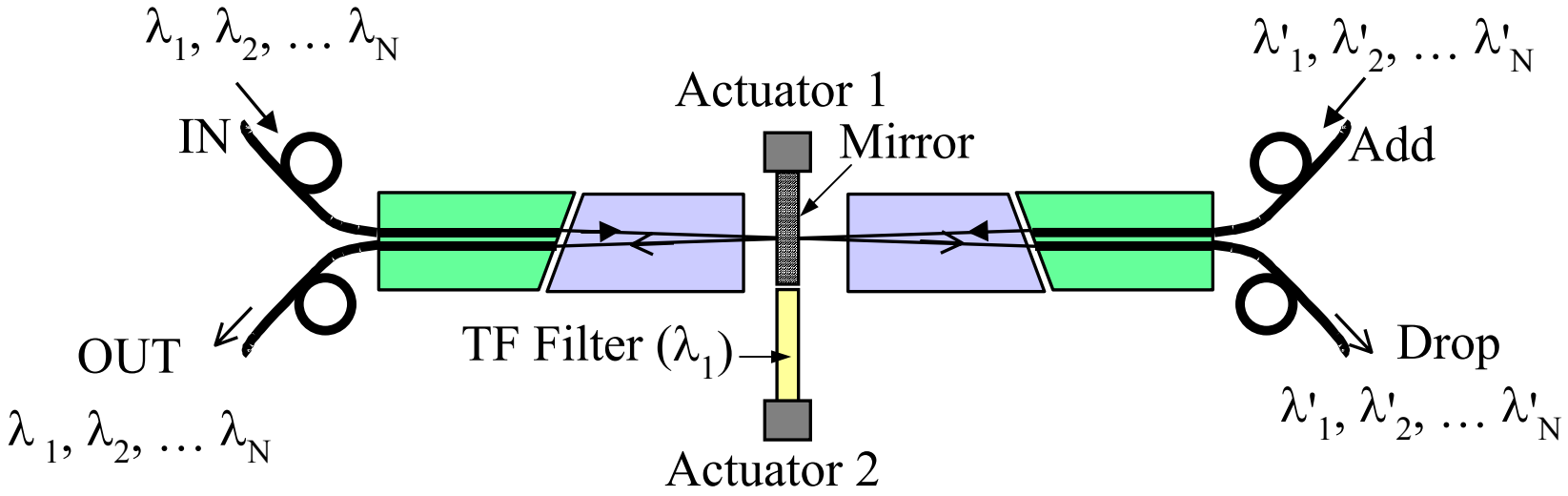
SMF: Single mode optical fiber; GRIN: Graded index
TF: Thin Film Filter

Ref: S. Sumriddetchkajorn, *Patent (Pending)*, 2003.

- **Thin Film Filter at λ1 in the Path**



- **Mirror in the Path**



Our Experimental Demonstration

Hand Operated Translation Stage

IN

$\lambda_1, \lambda_2, \dots, \lambda_N$

Mirror

TF Filter (λ_1)

SMF

$\lambda'_1, \lambda'_2, \dots, \lambda'_N$

Add

FC/APC

$\lambda'_1, \lambda_2, \dots, \lambda_N$

OUT

Drop

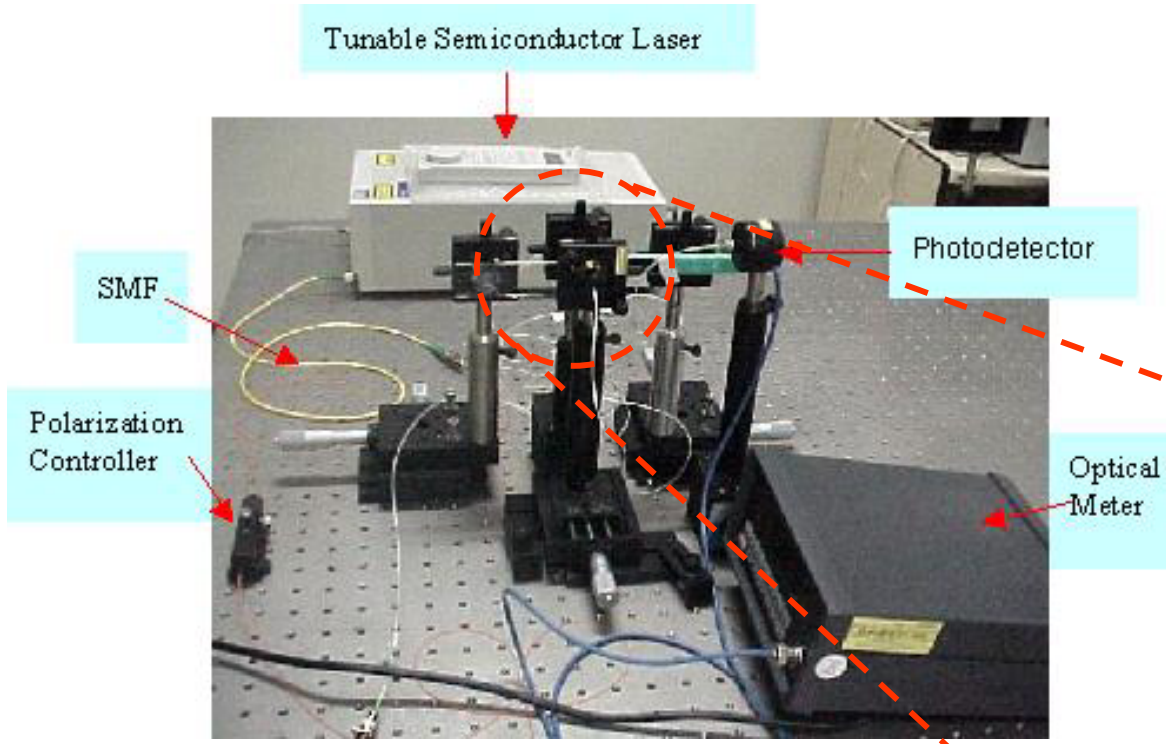
$\lambda_1, \lambda'_2, \dots, \lambda'_N$

Dual Fiber Collimator

Hand Operated Translation Stage

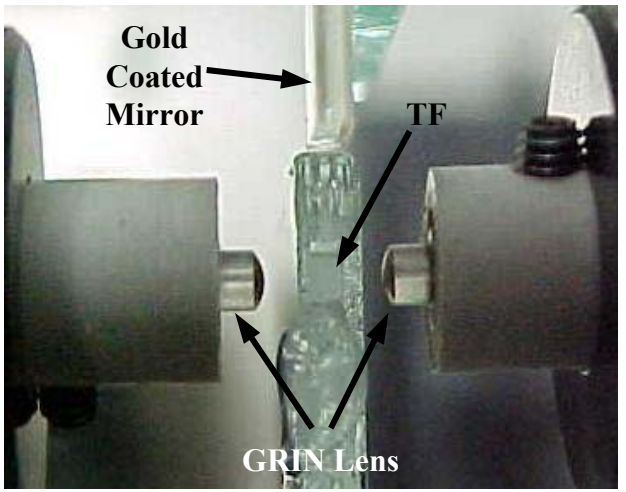
λ_1: 1545.65 nm

Photographs of Our Experimental Setup



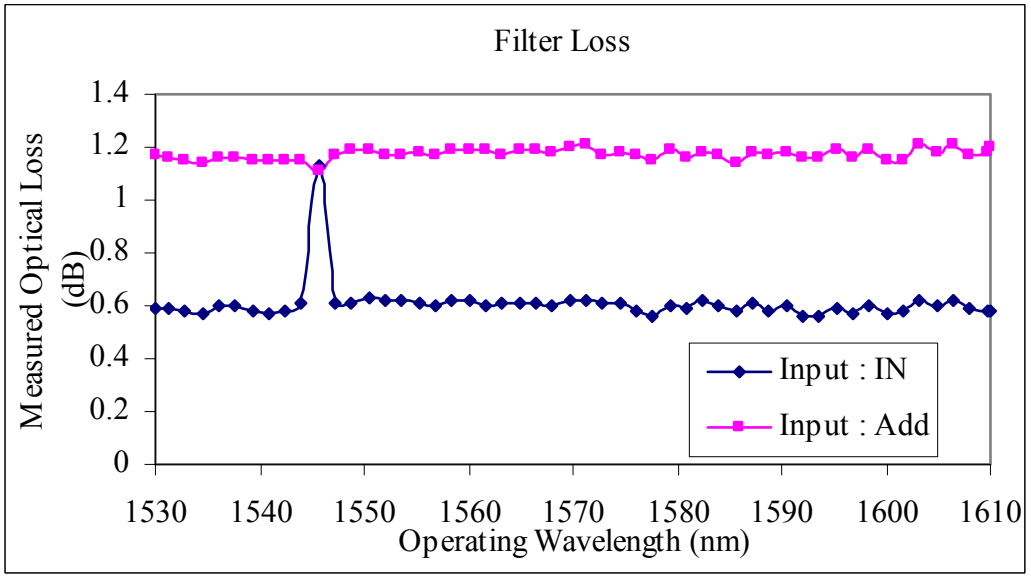
Overview

Closeup View



- Mirror: 50 nm gold coated mirror on one side
- Thin Film Filter: 4-cavity WDM Filter (1.4x1.4x1.0 mm^3) at 1545.65 nm

Measured Optical Loss



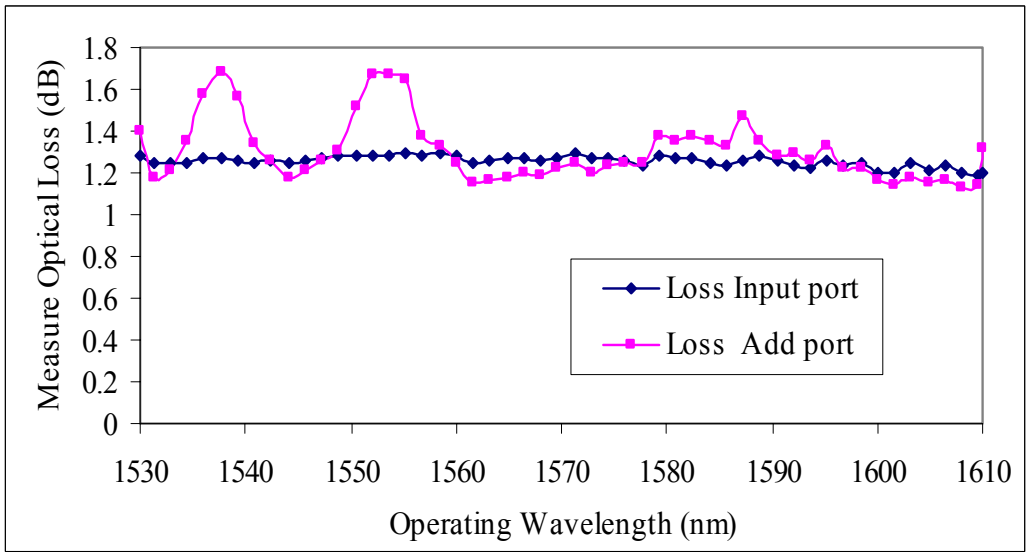
- Filter in the path

At 1545.65 nm: IN ➡ 1.12 dB

: Add ➡ 1.11 dB

Average: IN ➡ 0.6 ± 0.04 dB

: Add ➡ 1.17 ± 0.03 dB



- Mirror in the path

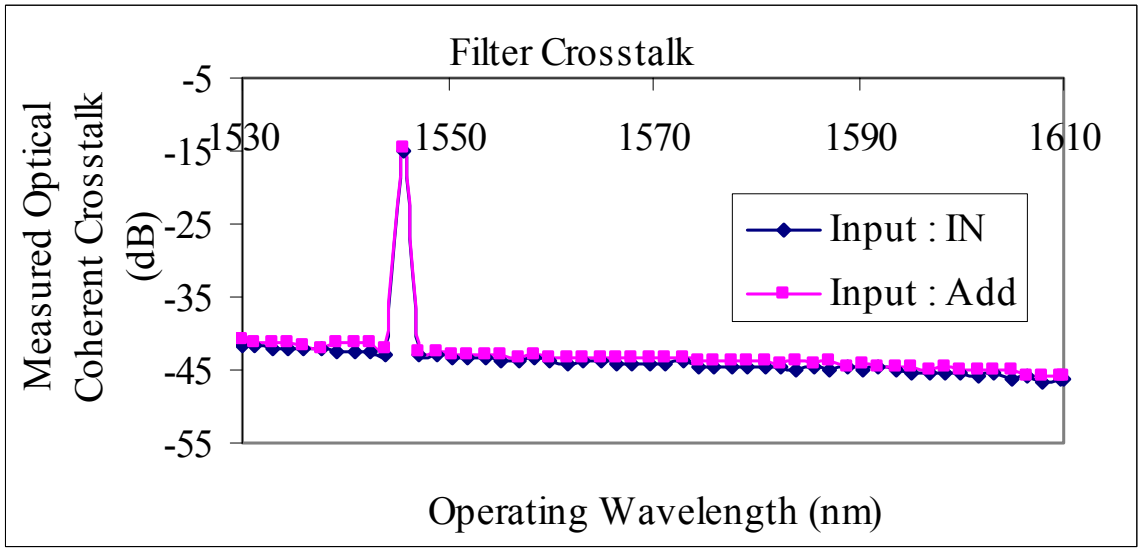
At 1545.65 nm: IN ➡ 1.25dB

: Add ➡ 1.21 dB

Average: IN ➡ 1.25±0.05 dB

: Add ➡ 1.3±0.28 dB

Measured Optical Coherent Crosstalk



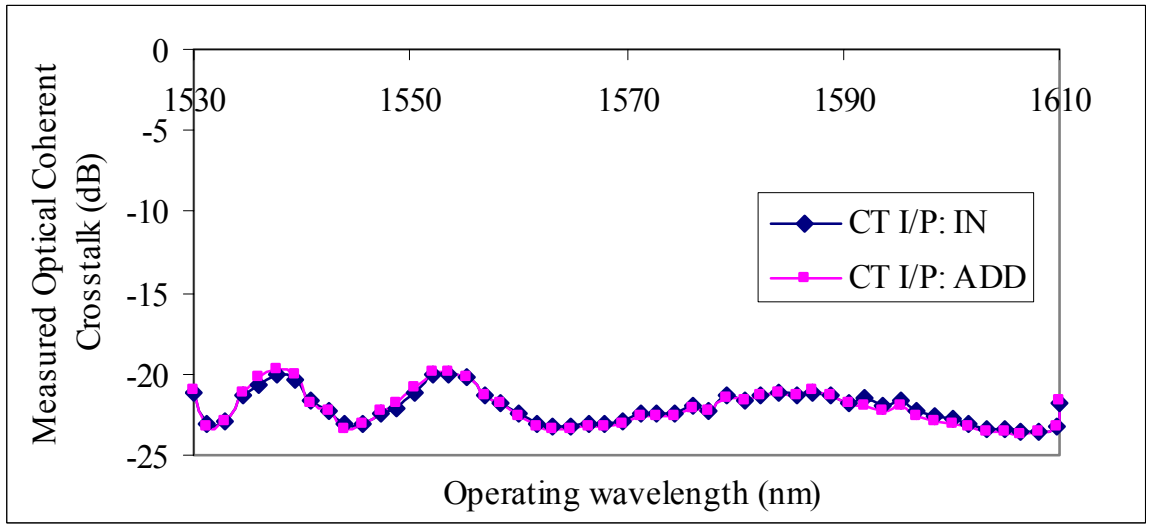
- Filter in the path

At 1545.65 nm: IN ➡ -15.12 dB

: Add ➡ -14.73 dB

Average : IN ➡ -43.5 dB

: Add ➡ -42.9 dB



- Mirror in the path

At 1545.65 nm: ➡ -23 dB

Average ➡ -22 dB

Measured Polarization Dependent Loss (PDL)

- Scrambles the input state of polarization via a mechanical polarization controller
- Observes the maximum and minimum optical output power

$$PDL = 10 log(P_{max}/P_{min}) \quad dB$$

$$PDL < 0.07 \quad dB$$

Limiting Factors

- Free Space Optical Alignment
- Quality of Mirror
- Quality of Thin Film Filter
- Loss from FC/APC Connectors

Conclusion

• Proposes a Reconfigurable Thin Film Filter -based 2x2 Fiber-Optic Switch Structure

Our Simple WDM Routing Structure

- N Our Proposed Switches
- 2 MUXs/DeMUXs
- No Optical Circulator

• Experimental Demonstration using a Commercially Available Thin Film Filter at 1545.65 nm

- Measured Optical Loss < 1.3 dB
- Measured Optical Coherent Crosstalk < -15 dB
- Measured PDL < 0.07 dB

• Future Work Relates to Commercialize Our Proposed Reconfigurable Thin Film Filter-based 2x2 Fiber-Optic Switch