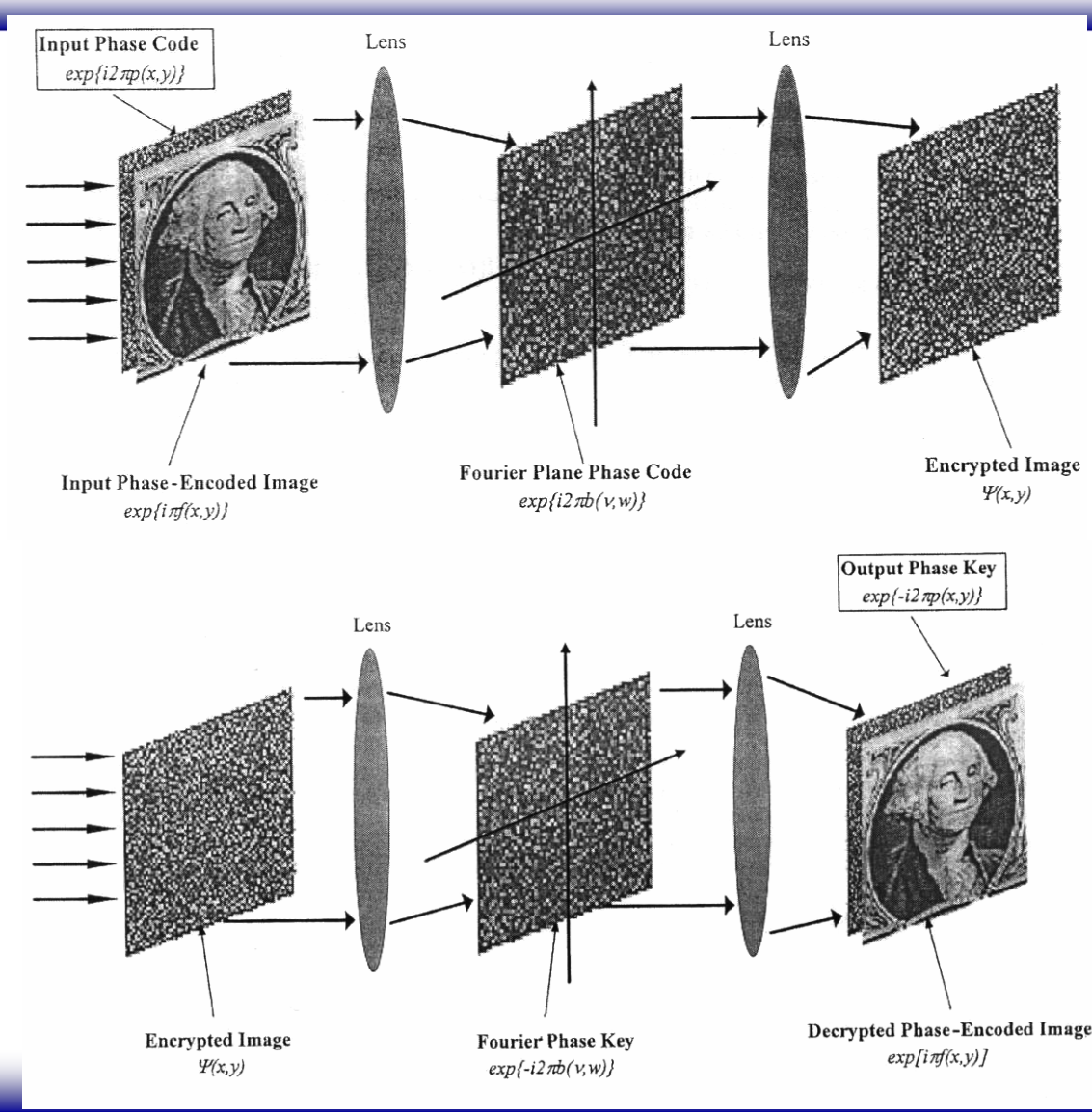
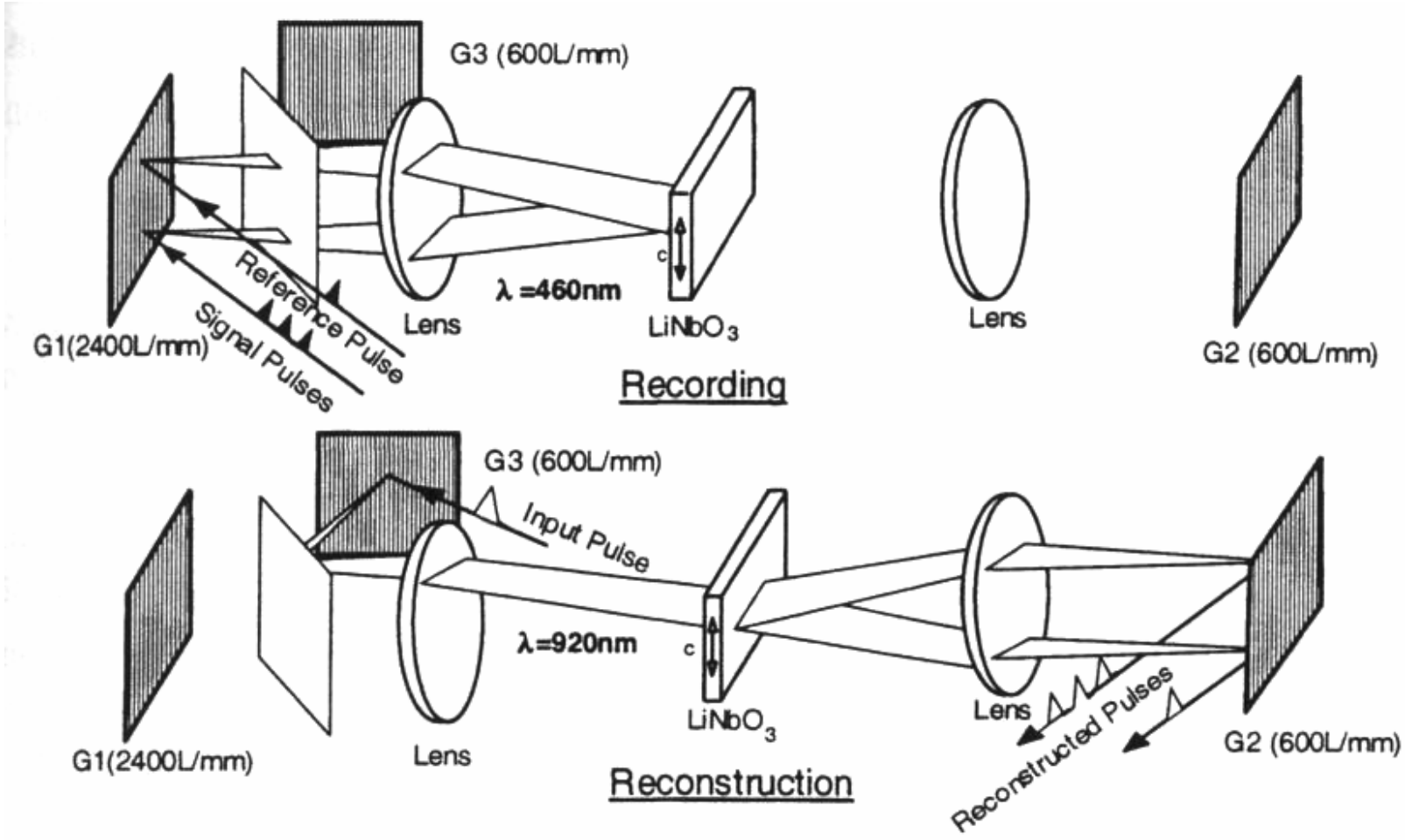
21. Others

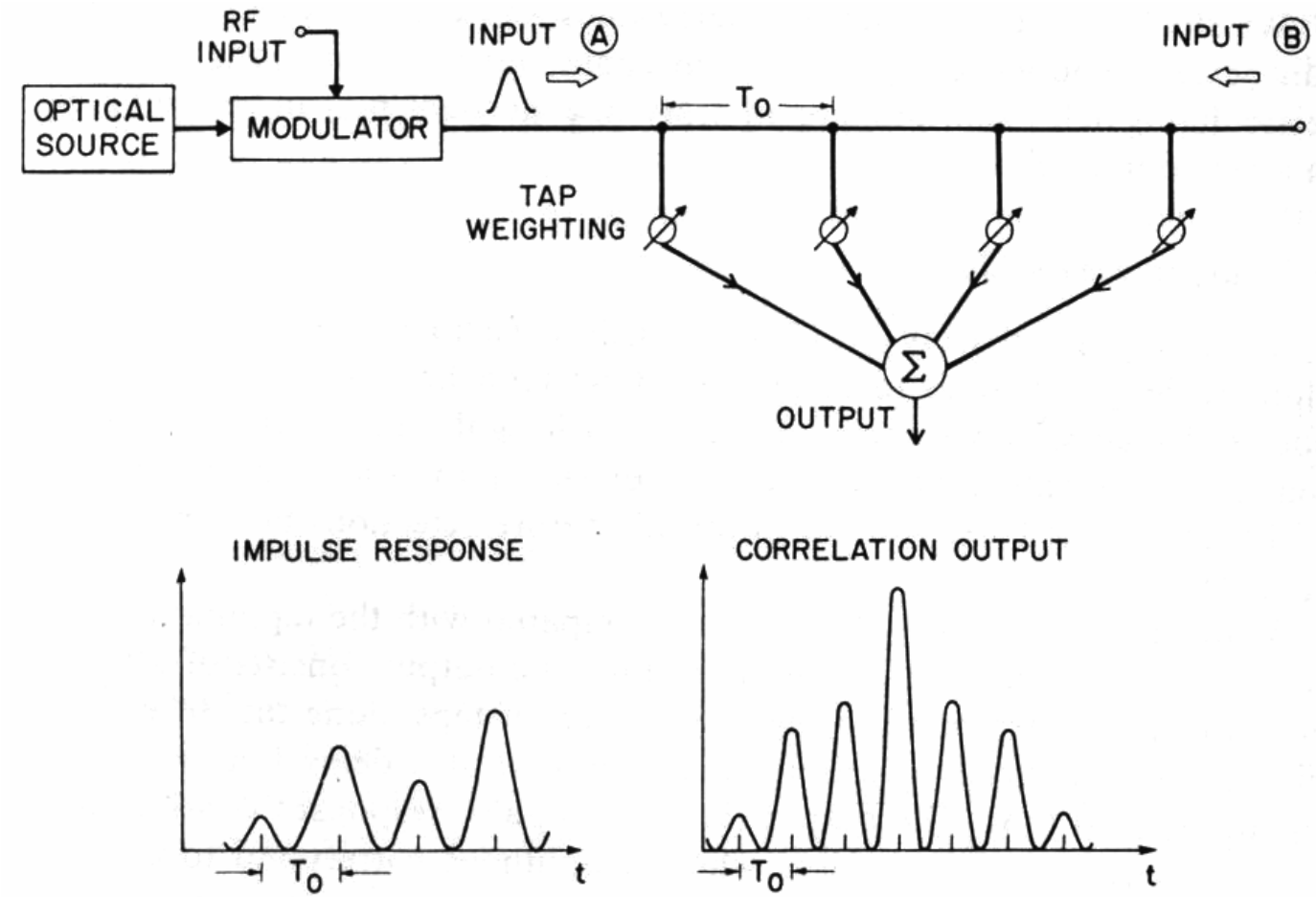
Phase Encrypted Image Processor



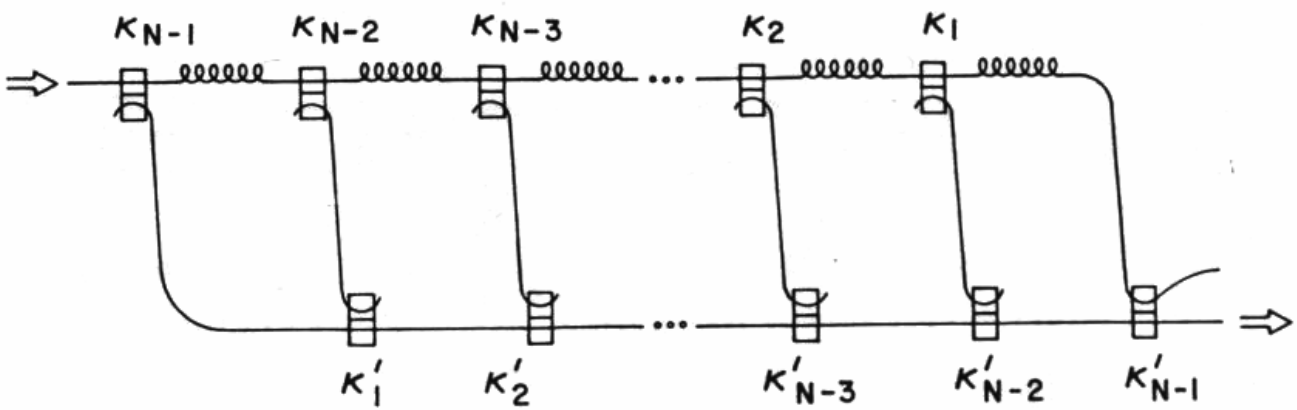
Femtosecond Optics for Optical Data Storage and Detection

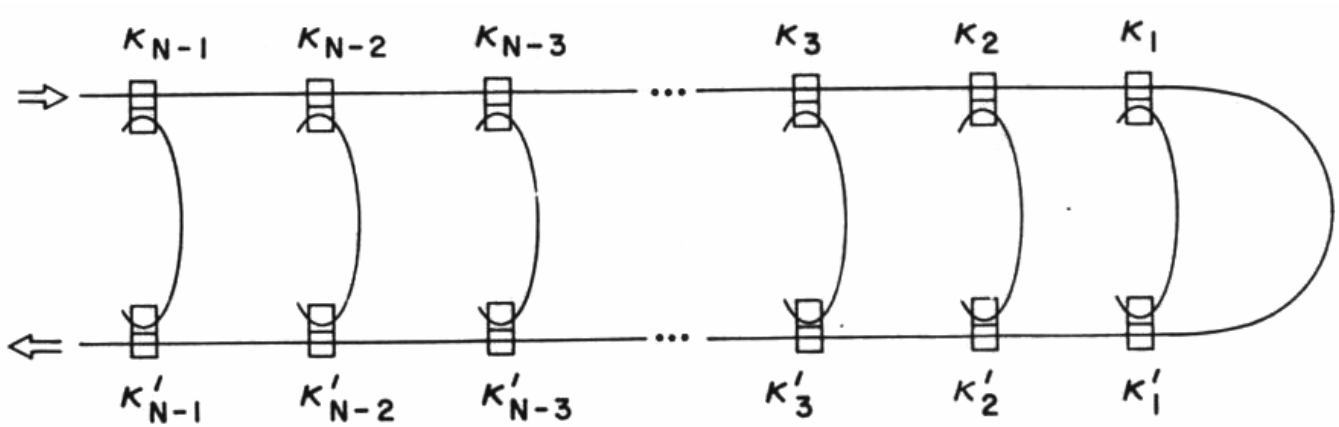


Delay-Line Signal Processor (I)

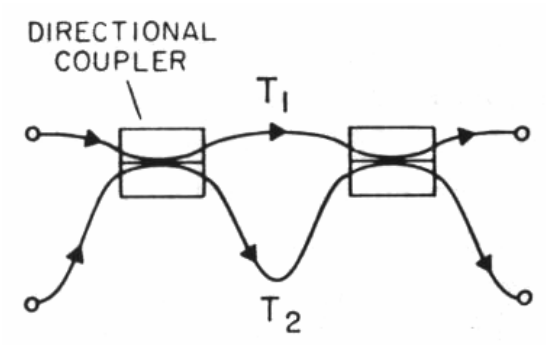


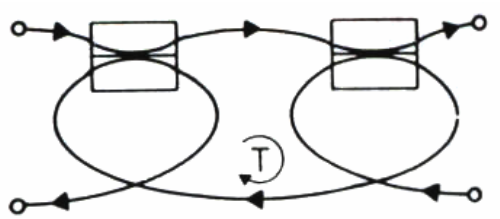
Delay-Line Signal Processor (II)

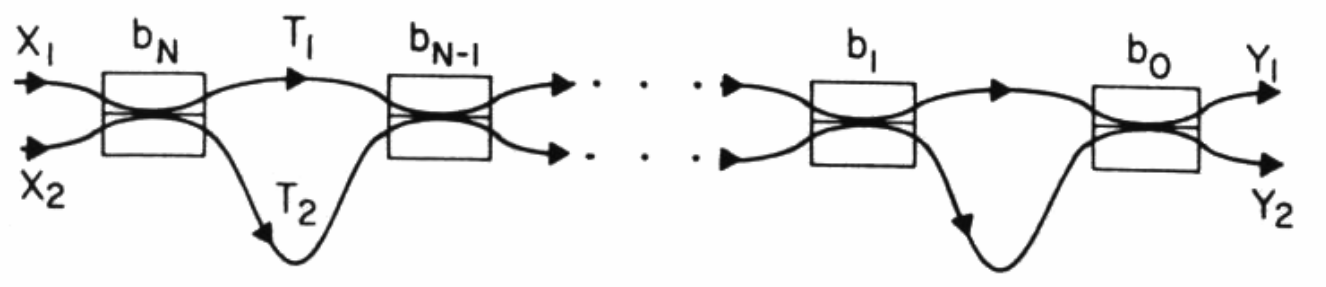


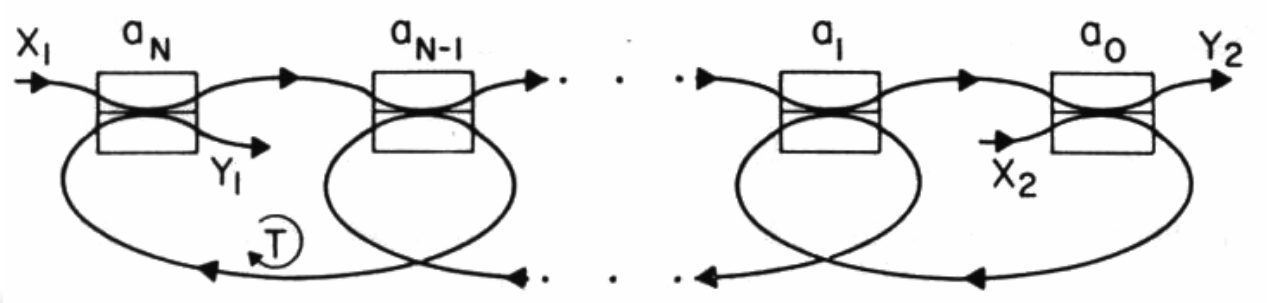


Delay-Line Signal Processor (III)

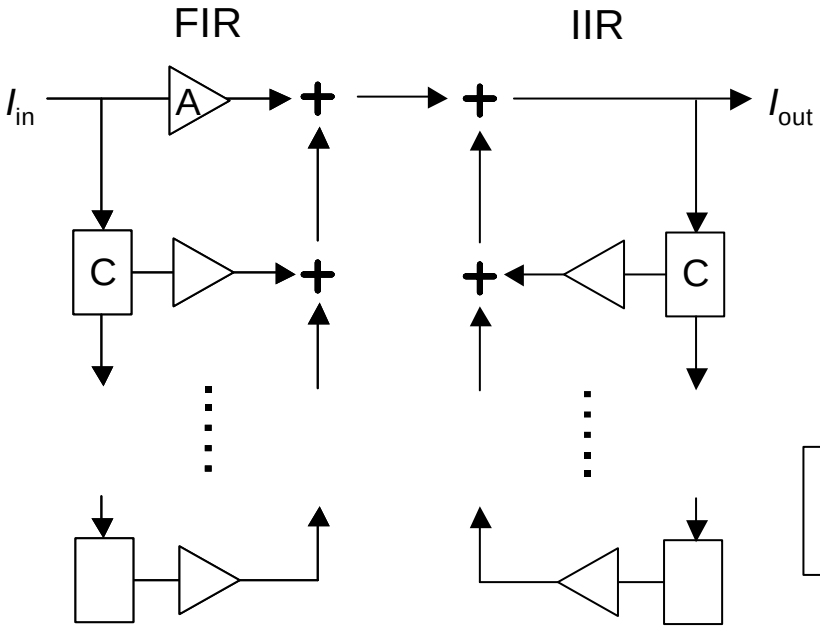


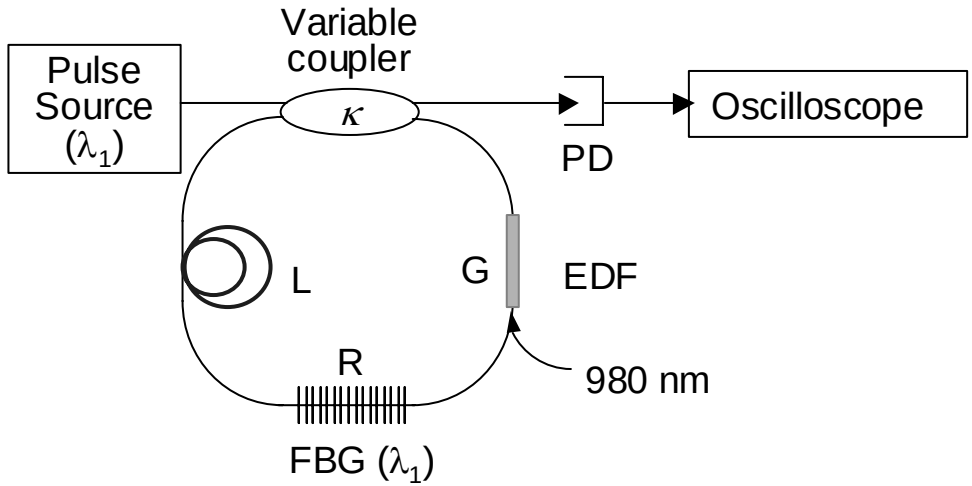




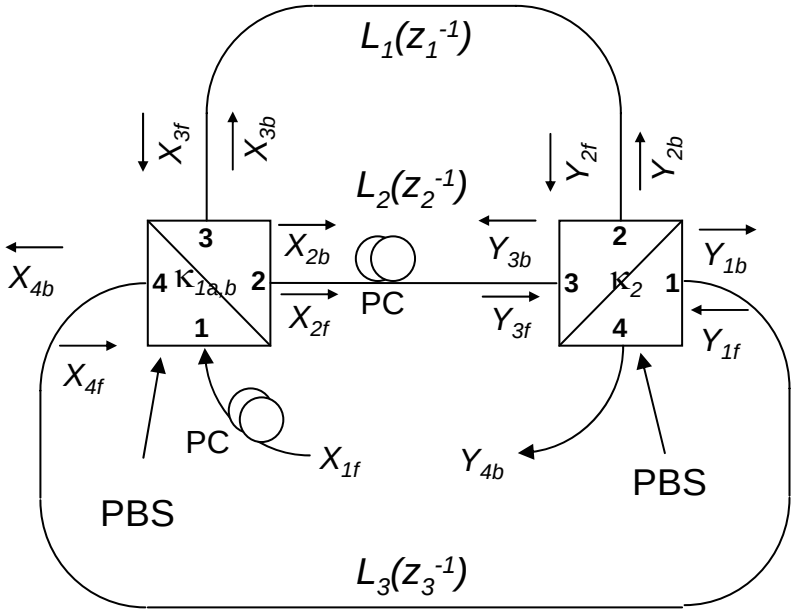


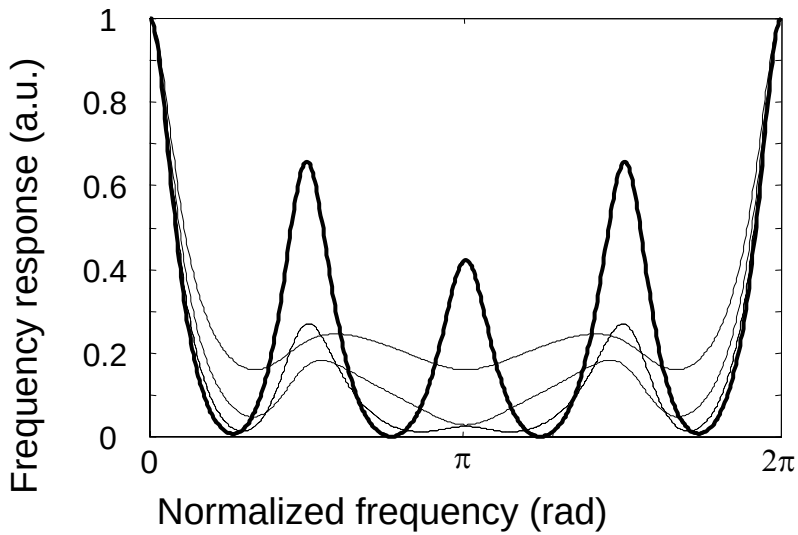
Delay-Line Signal Processor (IV)



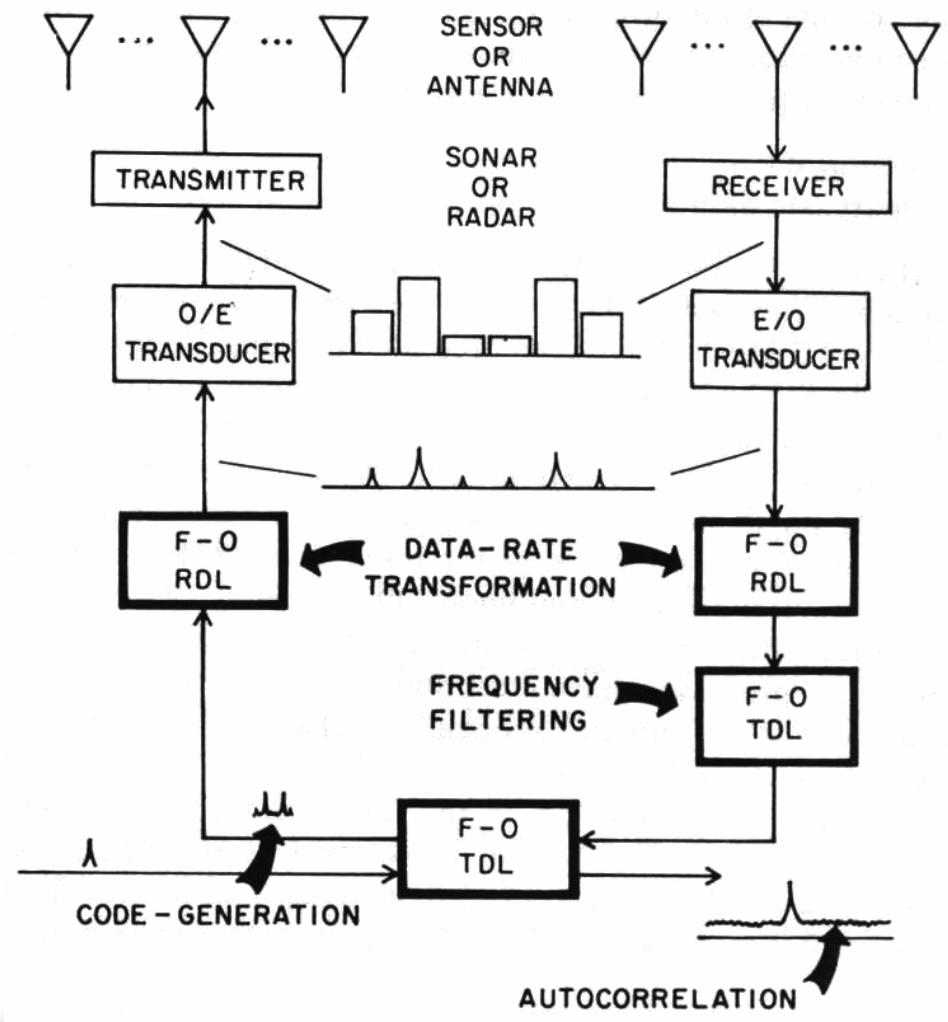


Delay-Line Signal Processor (V)



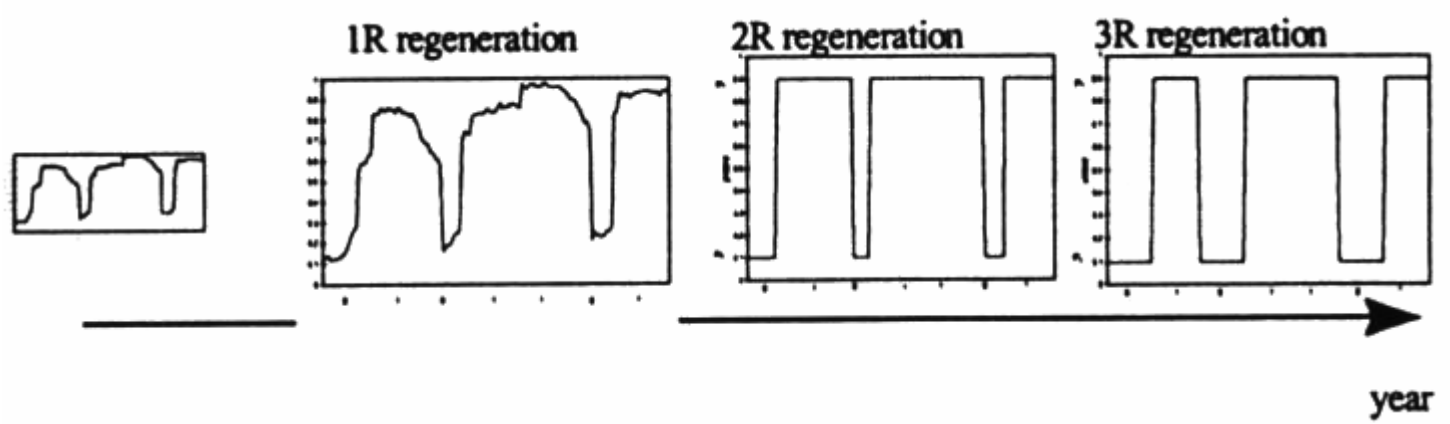


Delay-Line Signal Processor (VI)



Optical 3R Regeneration

- 1R – Amplification
- 2R – Amplification and reshaping
- 3R – Amplification, reshaping and re-timing

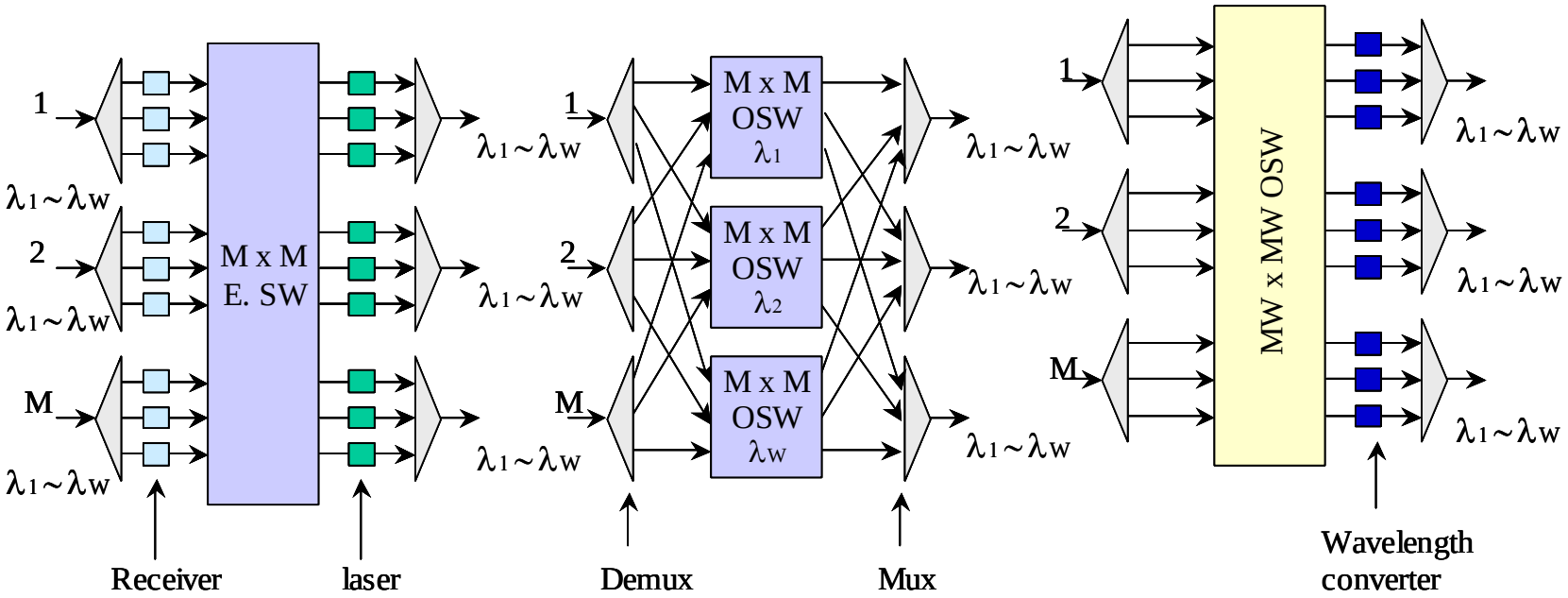


WDM-based OXC Technologies

Electro-Optical node
(OEXC)

Simple Optical node
(OXC w/o converter)

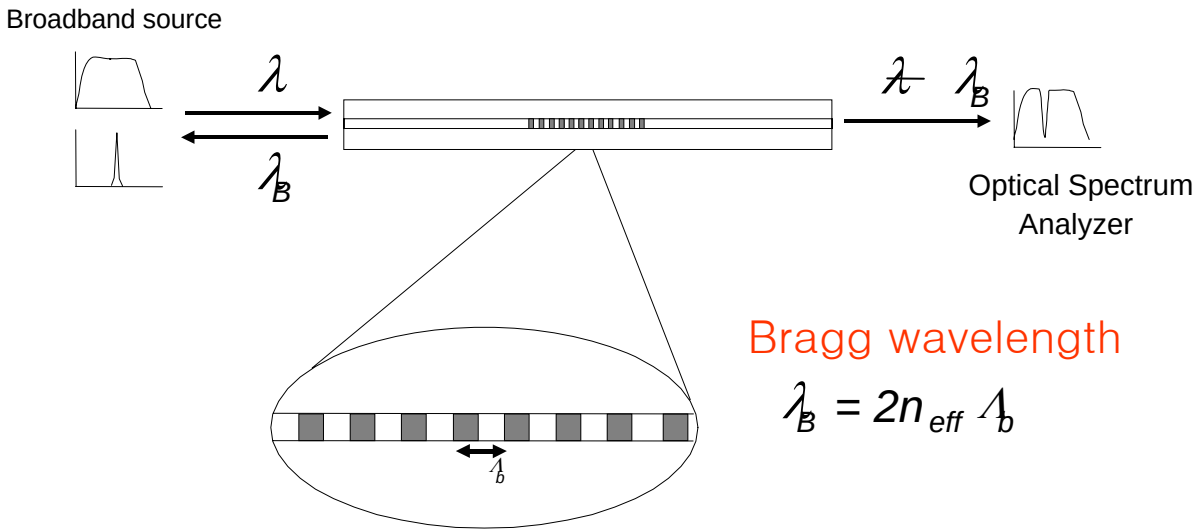
Full conversion optical node
(OXC with converter)



OXC System Venders Compared

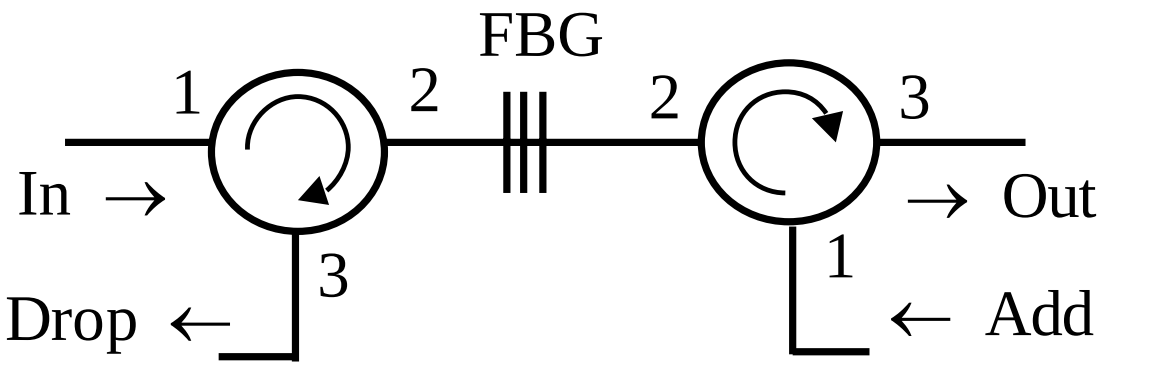
회사	Switch Type	대표제품	Spec	connectioin/ protection time	bandwidth	비고
ASTARTE	PZT(현재) Optical MEMS(향후)	STAR switch 7250	72*72(max) 576*576(향후)	150ms		단순한 all optic switch 시스템
Tellium	Electical switch(현재) + MEMS optic (향후)	AUROA optical switch	512*512	50ms	2.5Gbps OC-192ready	SONET performanc monitoring IP, SONE, ATM을 직접 연결
Lucent	Optical MEMS (Microstar)	WAveStar LambdaRouter	256*256	50ms		Bit rate and protocol transparency
Nortel	Electrical switch	OPTera Connect HDX	1000*1000	~ms	120Gbps~40Tbs	packet/optical integration
Xros	Optical MEMS switch	X-1000 OXC system	1152*1152	50ms		Noetel M &A
Cisco	Electrical switch	ONS 15900 Wav length Router	256*256	50ms	2.5Gbps	IP, SONET, ATM direct attaching Swoftware-based provisioning (WaRP)
Sycamore	Electrical switch	SN 16000	512*512		2.5Gbps	Modular Chasssis design VCSEL interconnetion
Ciena	Electrical switch	Multiwave CoreDirector	256*256		256*2.5Gbps or 64*10Gbps	Optical signaling and Routing protocol
Sirroco		Typhoon Optical edge switch			10Gbps	Sub-lambda multiplexing/switching
BrightLink	Electrical switch	Cleapath	1024*1024		1024*2.5Gbp 256*10Gbps	hypertorous switching fabric
Calient	Optical MEMS(SCREAM)	DiamondWav photonics switching system	4096*4096 (7 rack)		40Tbs(7rack)	MPLambdaS supporting
Marconis		Photon Interconnect System	32*32		2.5Gbps	
Htachi	Optical(mechanical) Polymer switch(향후)	AMN 7000 OXC systme	16*16	150ms		

Fiber Bragg Gratings (FBGs)



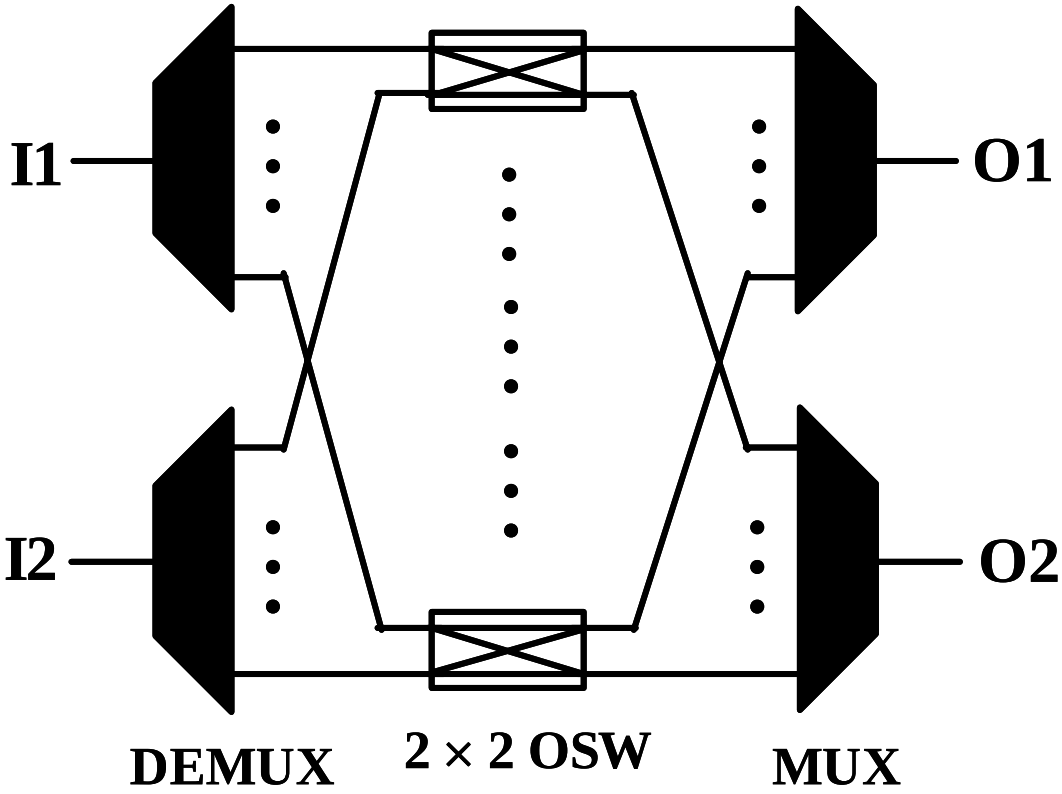
- FBG: a periodic perturbation of the refractive index along the fiber length
- Advantages: all-fiber geometry, good filtering shape, low insertion loss, low cost

Basic Configuration of WADM using Optical Circulators and FBGs

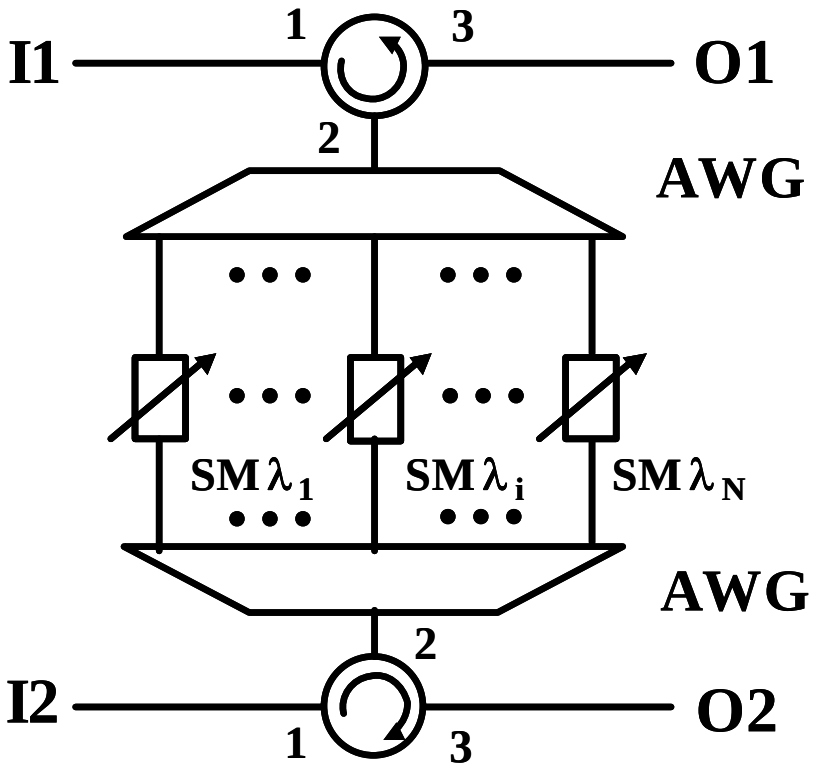


- Simple structure
- Low crosstalk (not interferometric mechanism)
- Commercially available

Conventional OXC (C-OXC)

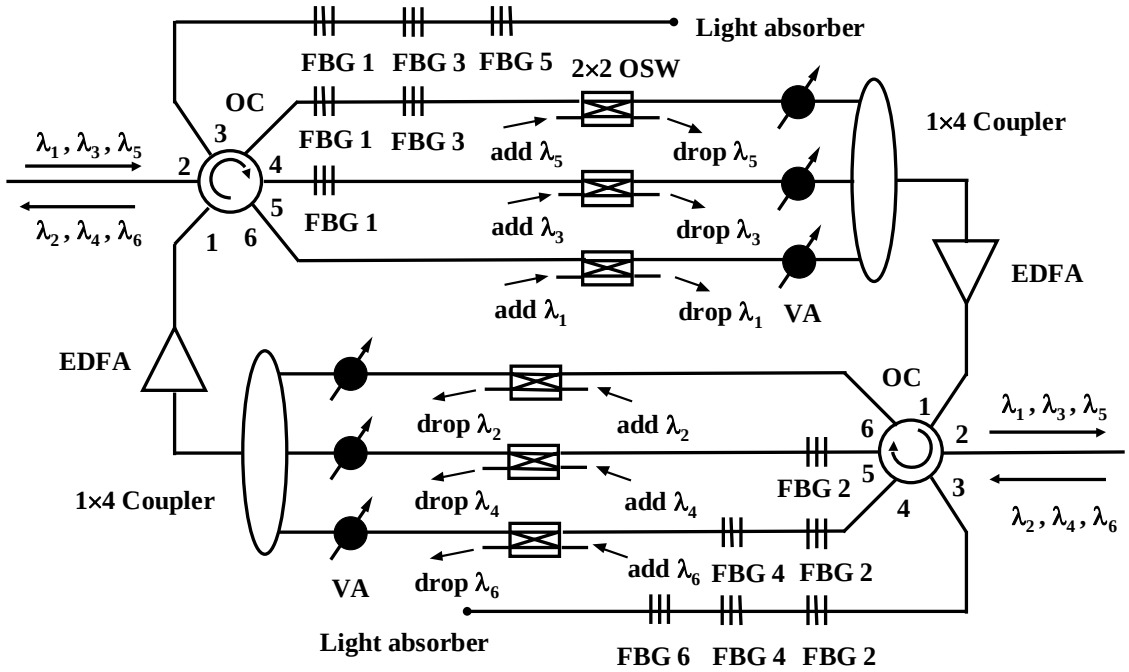


Reflection-Type OXC (R-OXC)



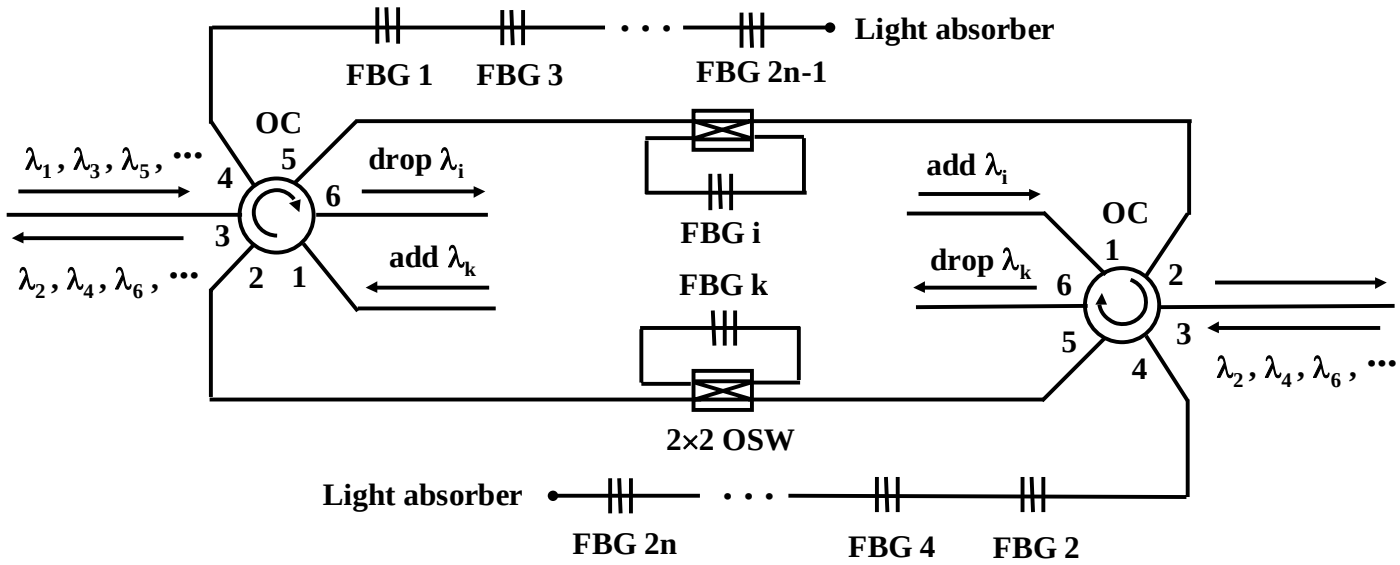
- Compared with the C-OXC, it halves the number of a WDM MUX/DEMUX pair.
- J. Kim *et al.*, *Electron. Lett.*, vol. 36, no. 1, pp. 67-68, 2000.

Configuration of B-WADM (I)



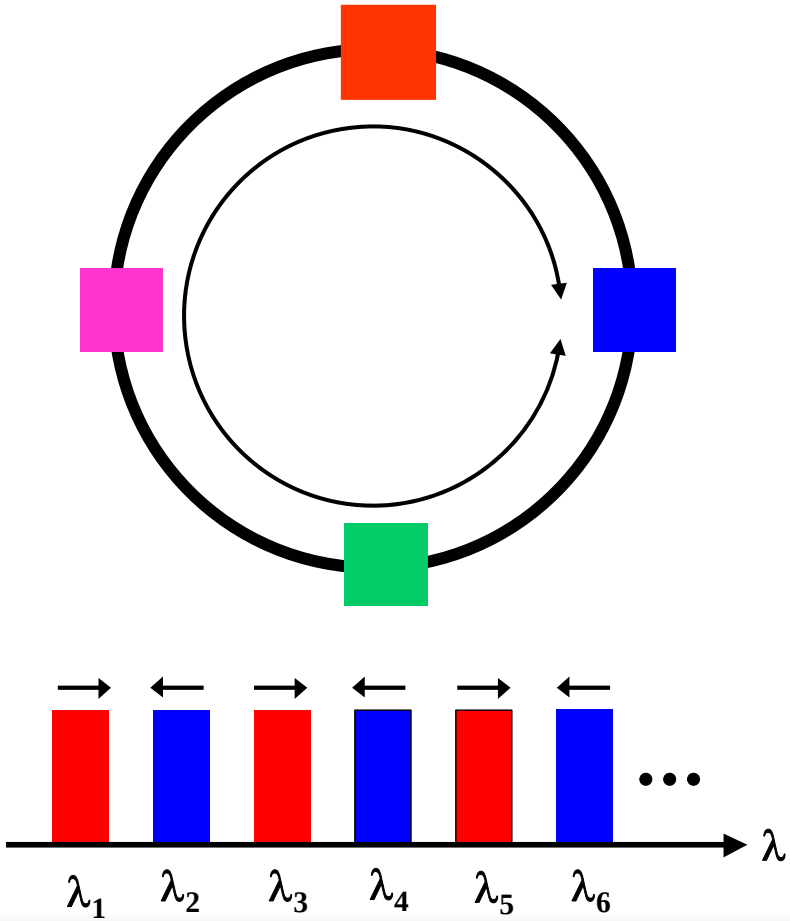
- Reduction of two 3-port optical circulators - low cost
- Compared with MUX/DMUX, good filtering shape of FBGs

Configuration of B-WADM (II)



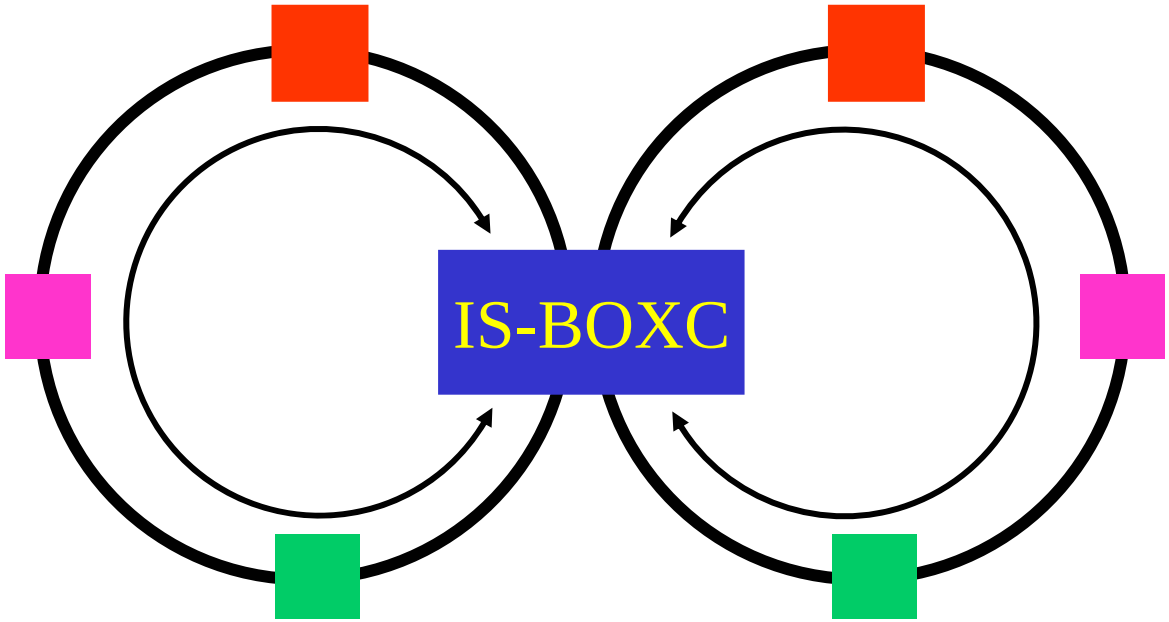
It is the fittest for B-WADM node that switches only one optical channel.

Single Fiber Bidirectional Transmission



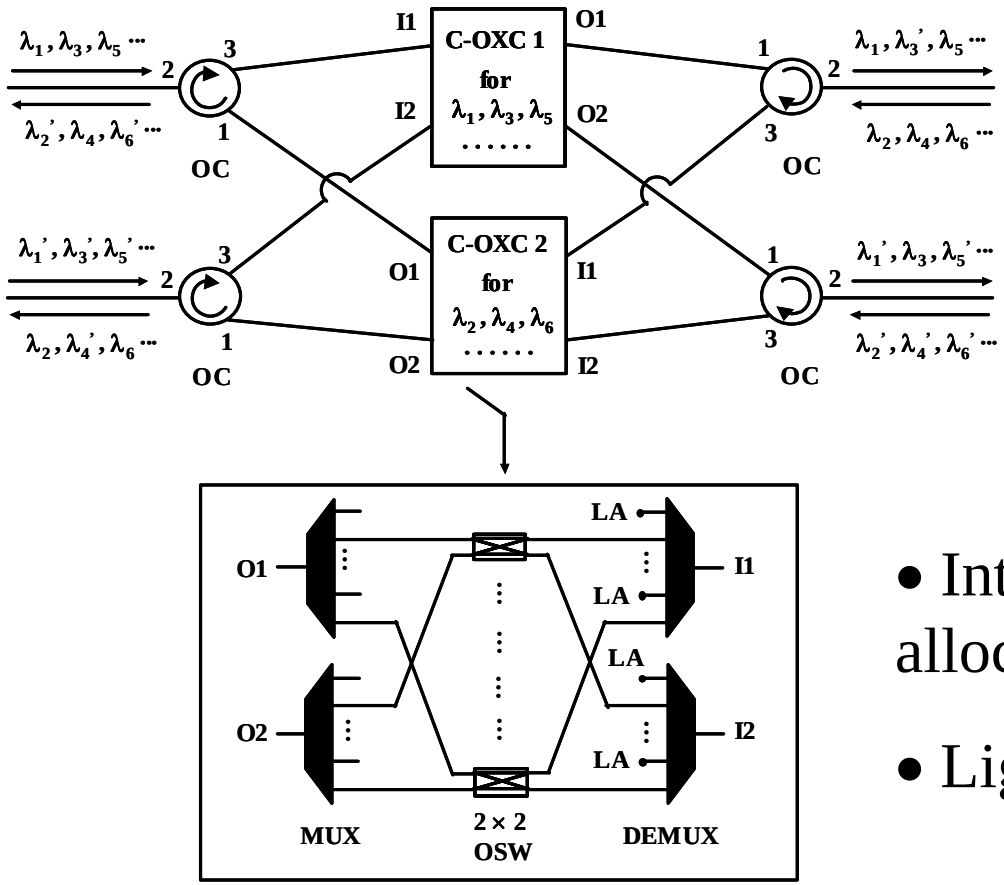
- The number of fiber links is halved.
- When the wavelength allocation of each direction is interleaved, fiber nonlinear effects such as four wave mixing can be reduced.

IS-BOXC in a Single-fiber Bidirectional Ring Networks



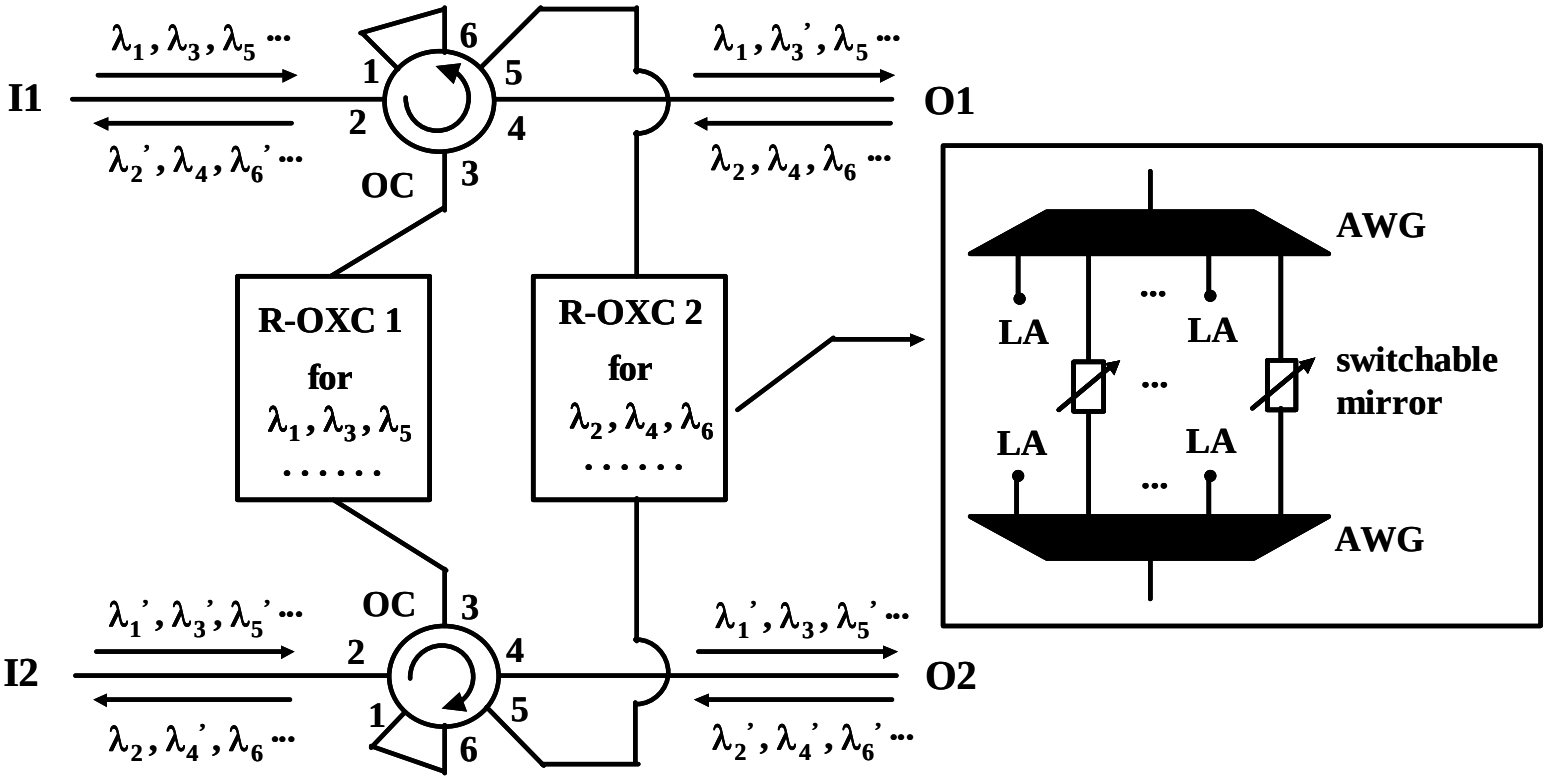
Independently switchable bidirectional OXC (IS-BOXC) switches each bidirectional signal, both independently and simultaneously.

IS-BOXC based on the C-OXC

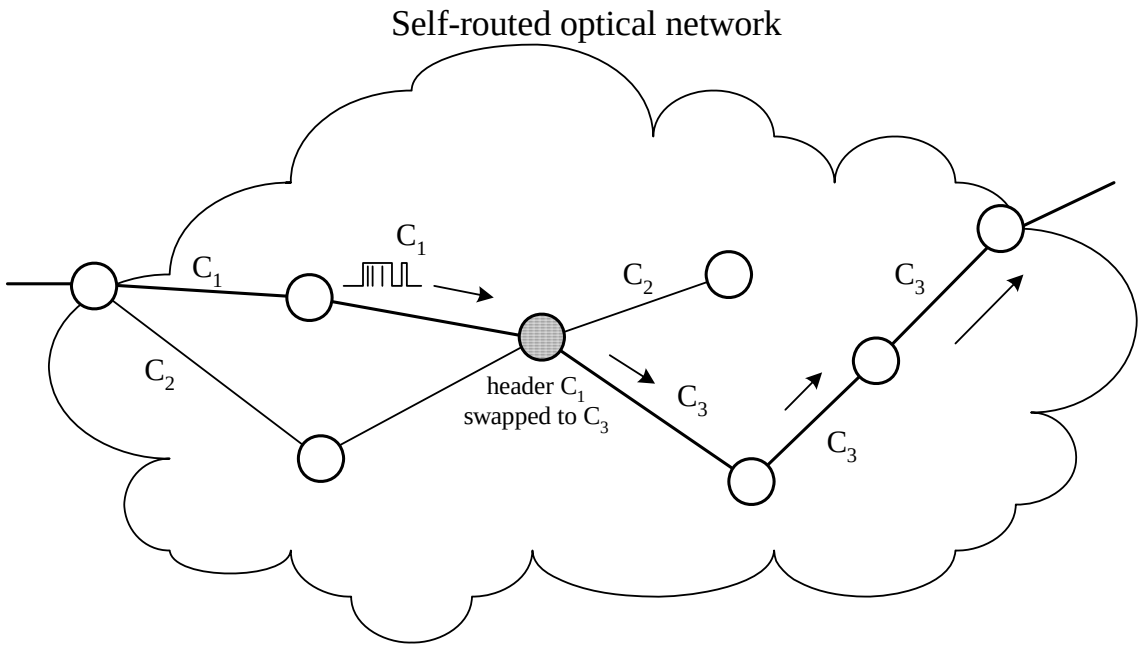


- Interleaved wavelength allocation of DEMUX
- Light absorber

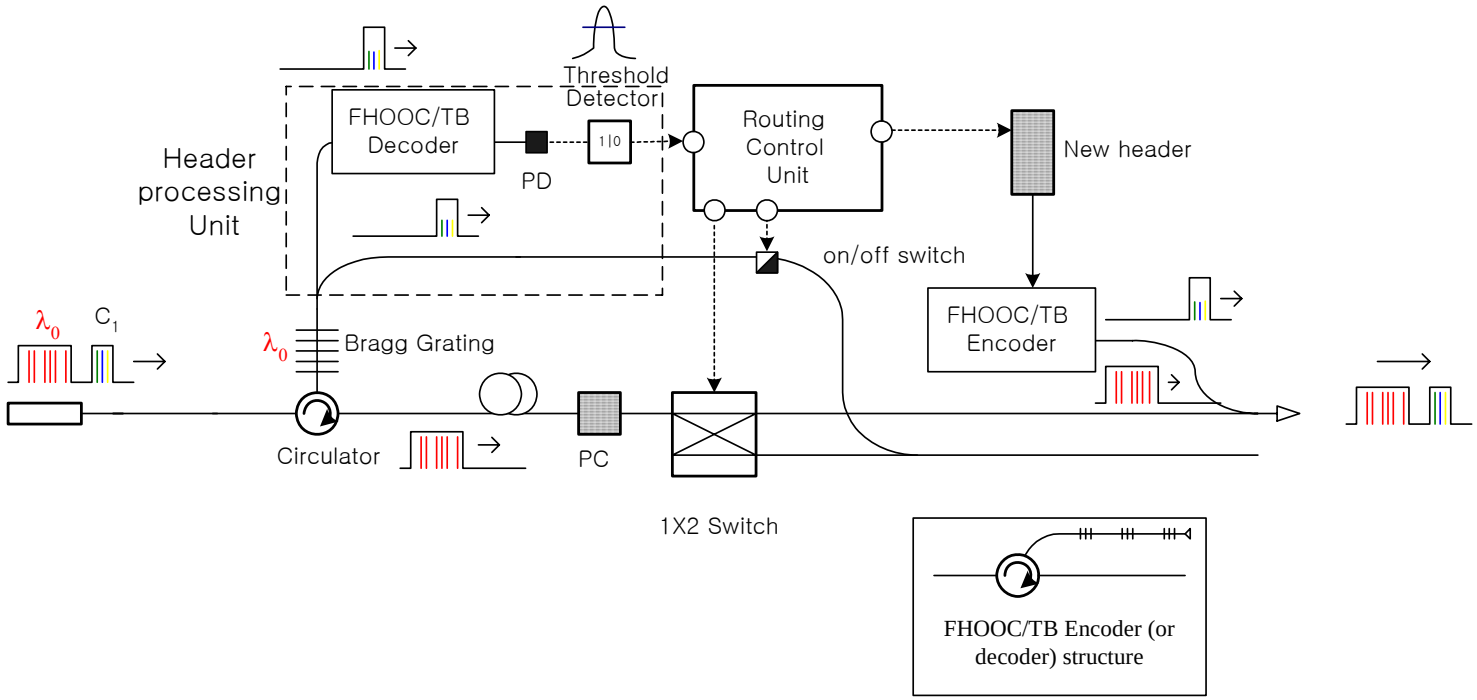
IS-BOXC based on the R-OXC



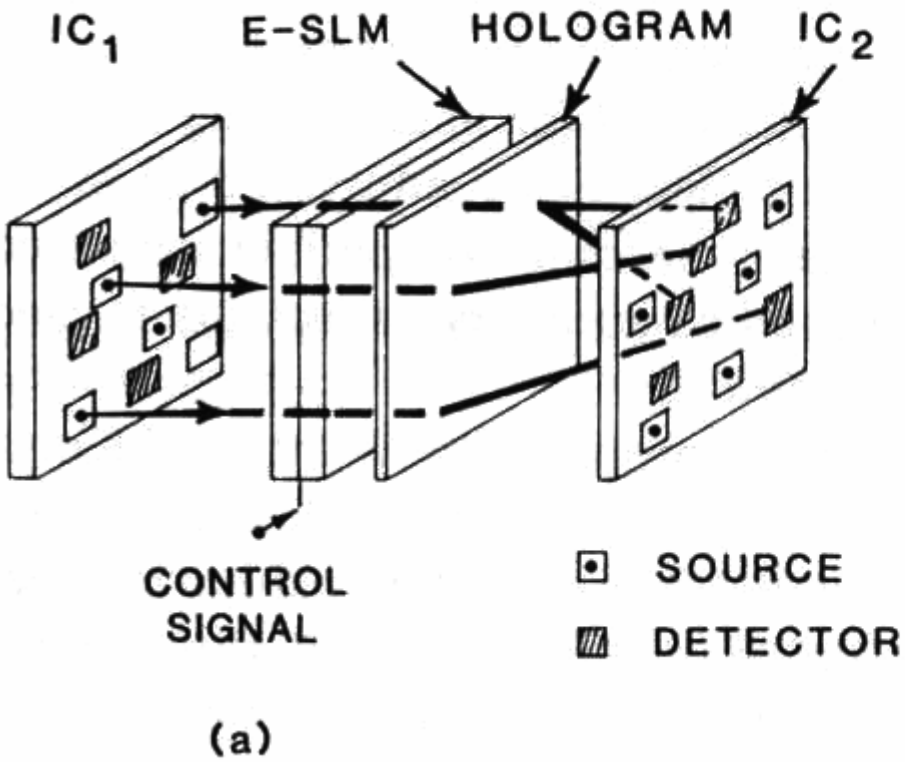
Self-Routed Optical Network

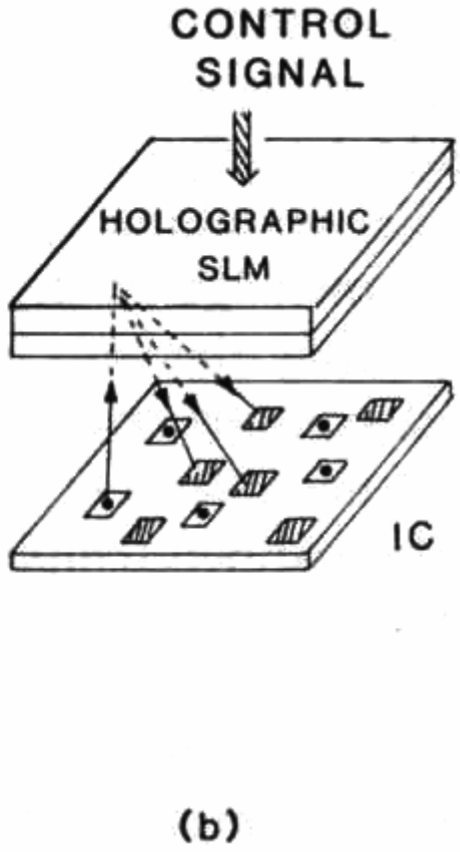


Self-Routed Optical Switching System



Reconfigurable Free-Space Optical Interconnection





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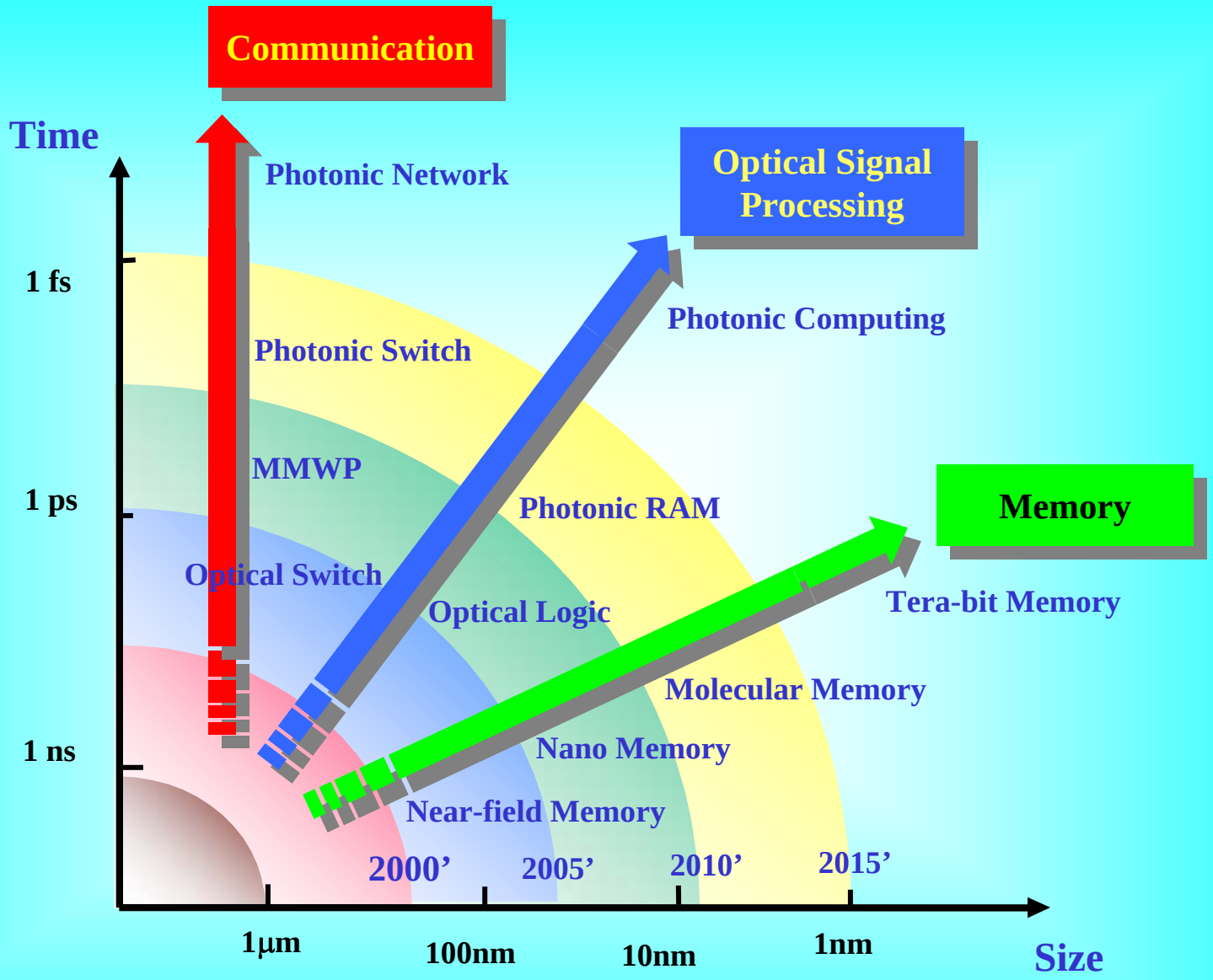
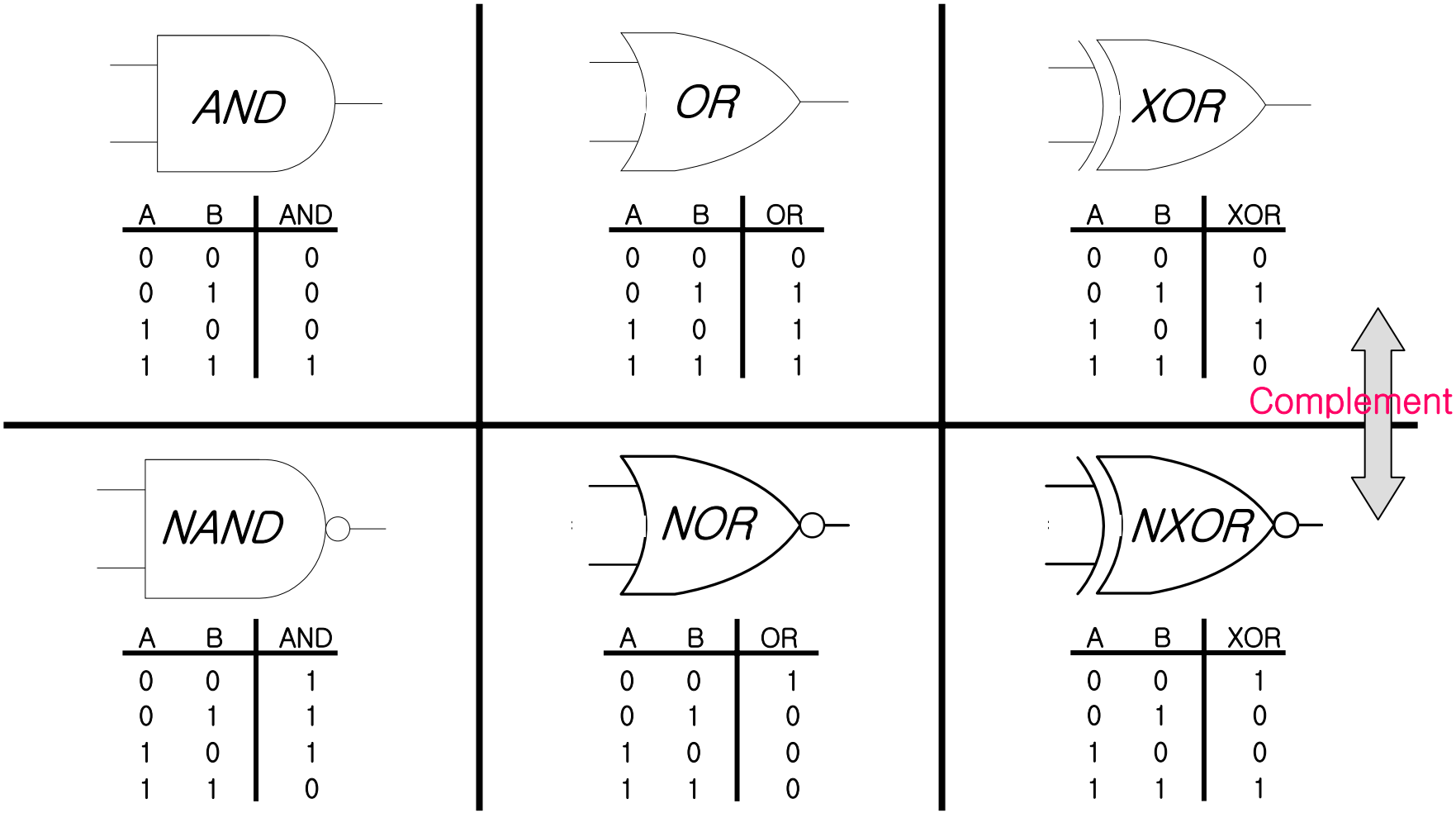

Communication
Time
Photonic Network
Optical Signal Processing
1 fs
Photonic Switch
Photonic Computing
MMWP
1 ps
Photonic RAM
Memory
Optical Switch
Optical Logic
Tera-bit Memory
Molecular Memory
1 ns
Nano Memory
Near-field Memory
2000’
2005’
2010’
2015’
1μm
100nm
10nm
1nm
Size

Fundamental Logic Gates



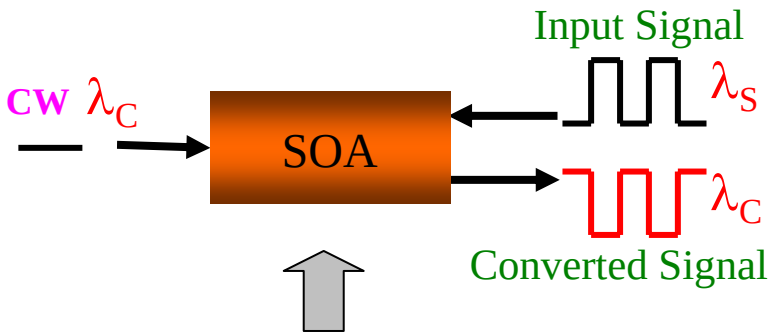
All-optical Logic Gates World-Wide

Logic	Optical Gate Implementation	Remarks
AND	FWM in SOA	10Gbps [95]
	Nonlinear Optical Loop Mirror in fiber (NOLM)	10Gbps [98]
	Nonlinear transmission in EAM	10Gbps [01]
	SOA based UNI	100Gbps [98]
OR	SOA based UNI	10Gbps [00]
	Monolithically integrated IWC [MI]	10Gbps [96]
XOR	SOA fiber Sagnac gate	10Gbps [99]
	SOA-assisted fiber Sagnac gate	5Gbps [99]
	SOA-based UNI	20Gbps [00]
	SOA-based cross-polarization modulation	5Gbps [01]
	Integrated SOA-based IWC [MZ]	20Gbps [00]
	Integrated SOA-based IWC [MI]	10Gbps [01]
NAND	Negative nonlinear absorption effect in Er-doped aluminosilicate glass	1 Gbps [99]
NOR	SOA (XGM)	0.1Gbps [97]
	two-section SOA (0.5 +1.5mm)	5Gbps [99]
NXOR	Integrated SOA-based IWC [MZ]	10 Gbps [01]

Fundamental Principles of All-optical Logic

이석

XGM



Gain Saturation

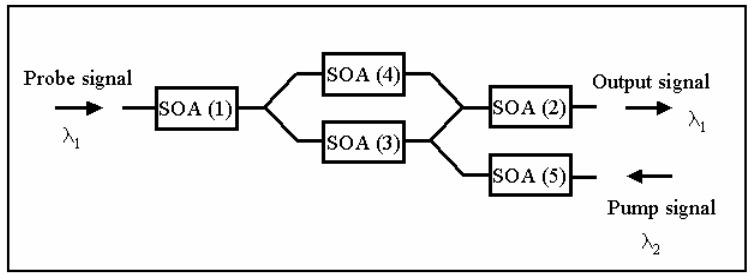
Input signal λ_S sweeps the carrier when input signal with high power is asserted.

Input signal λ_S with high power ➔ CW λ_c with low power

Input signal λ_S with low power ➔ CW λ_c with high power

Output signal λ_c is inverted signal of input signal λ_S .

XPM



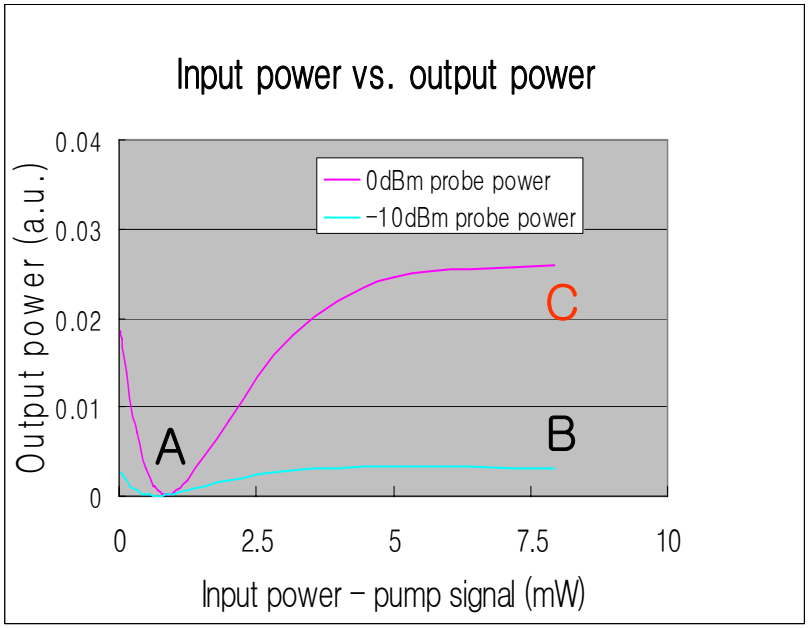
- **Carrier density of SOA (3) and SOA (4) is changed due to probe signal and pump signal.**
- **Change of carrier density causes the variation in refractive index.**
- **Due to the reason above, change in phase occurs.**
- **Interferometric effects at the summation point of SOA (3) and SOA (4) causes the variation of output power.**

☑Phase difference of π ➔ minimum output power.
☑Phase difference of 0 ➔ maximum output power.

All-optical AND gate (KIST)

XPM wavelength converter with definable binary point of Pump and Probe signals

Static Characteristics



Probe signal	*Pump signal*	*Output*	*Position*
LOW (0)	LOW (0)	LOW (0)	A
LOW (0)	HIGH (1)	LOW (0)	B
HIGH (1)	LOW (0)	LOW (0)	A
HIGH (1)	HIGH (1)	HIGH (1)	C

Logic AND : Experimental Set-up

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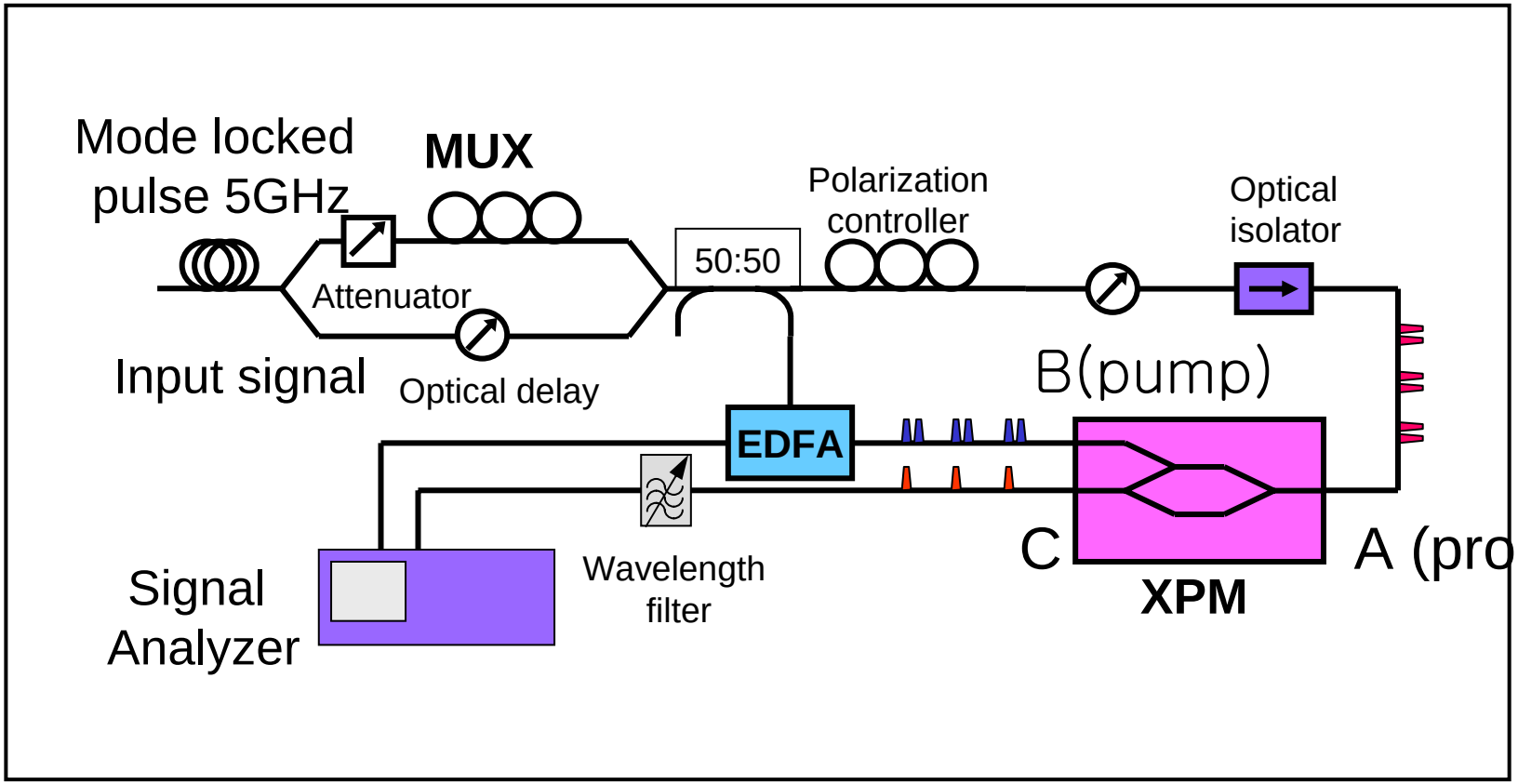

Logic AND : Results (20 Gb/s)

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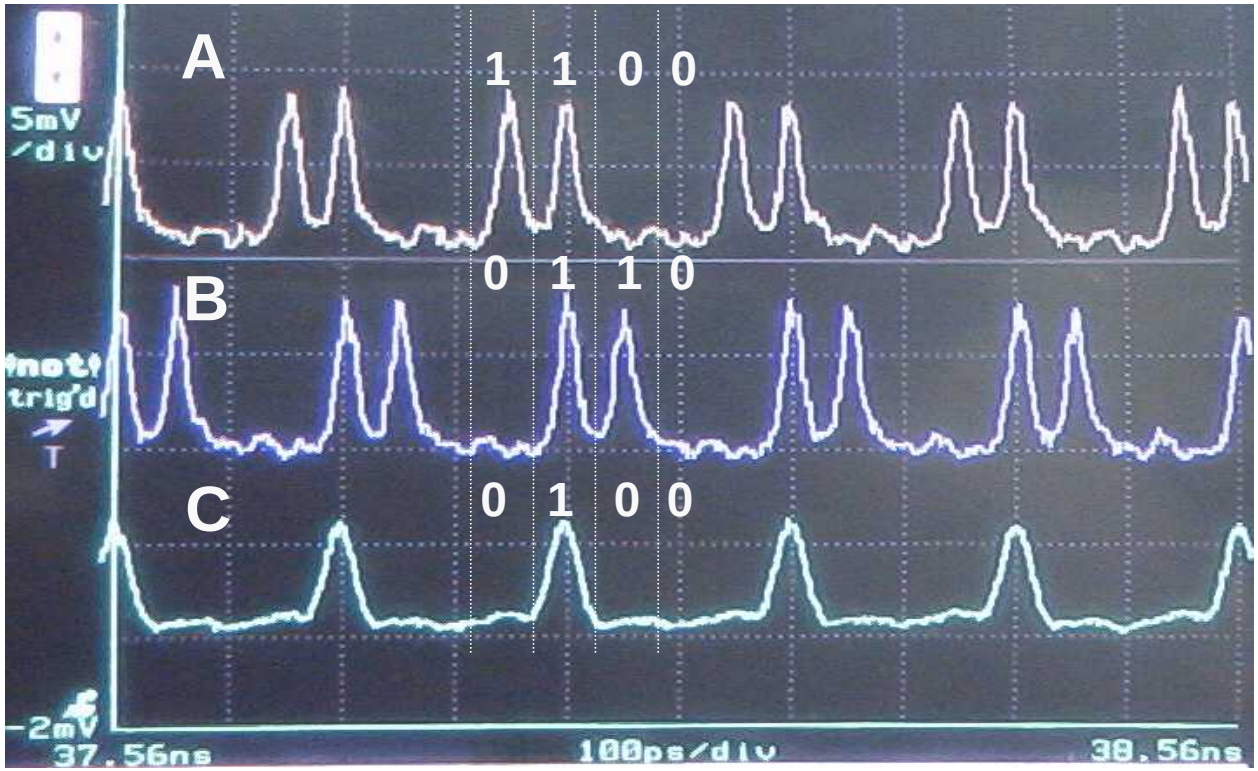

"All-Optical AND Gate Using Probe and Pump Signals as the Multiple Binary Points in Cross Phase Modulation," Japan Journal of Applied Physics, Vol. 41, No. 5A, May, 2002.

Serial-to-Parallel Data Converter Based on SOA-MZI

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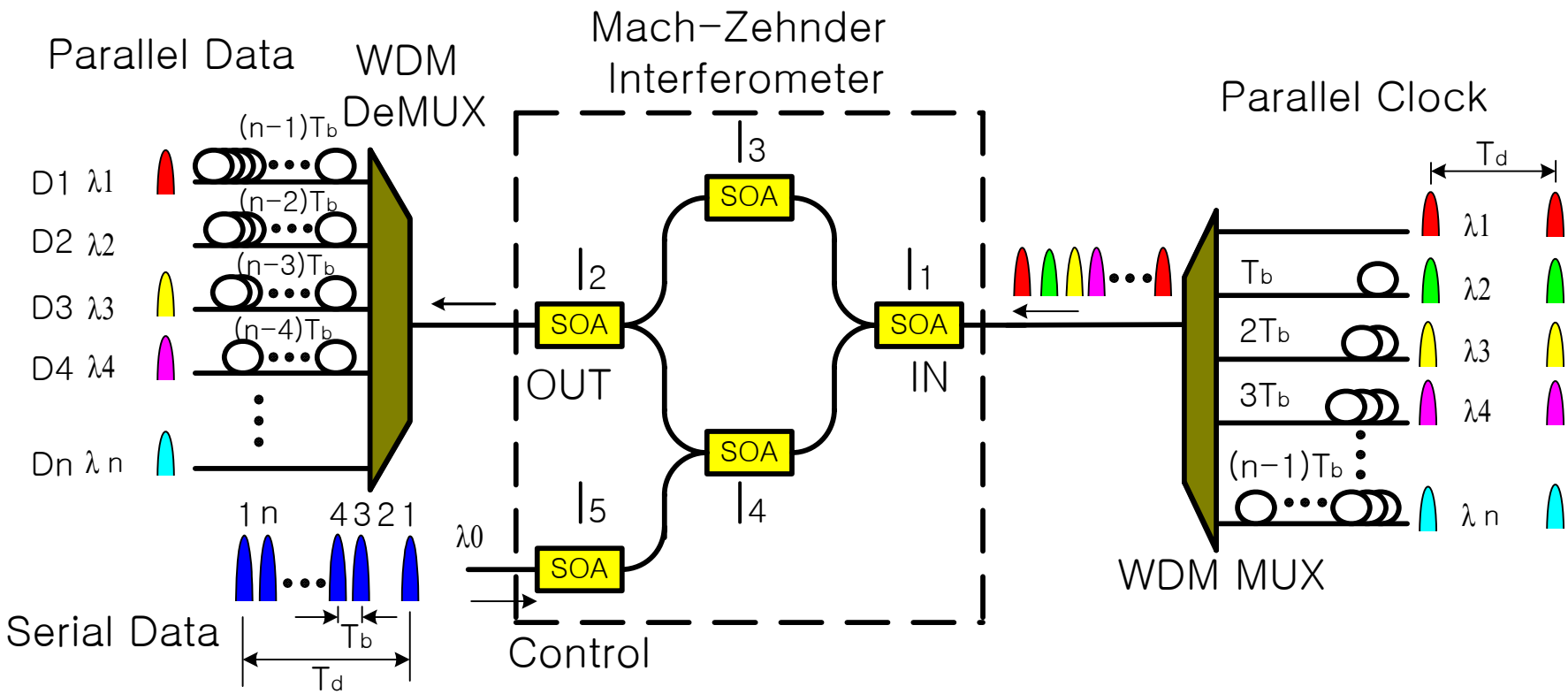

- WDM multiplexer, MZI, WDM demultiplexer
- Using wavelength conversion based on MZI

MZI-Based Serial-to-Parallel Data Converter Experiment

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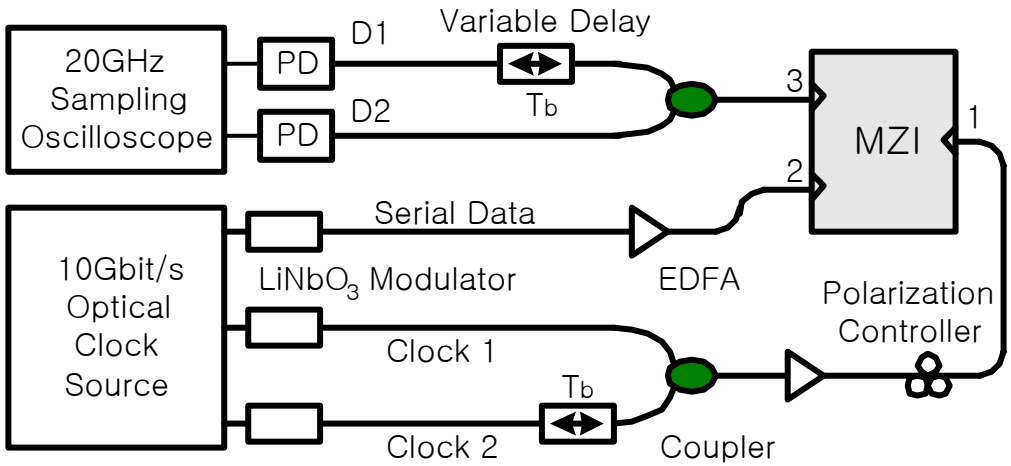
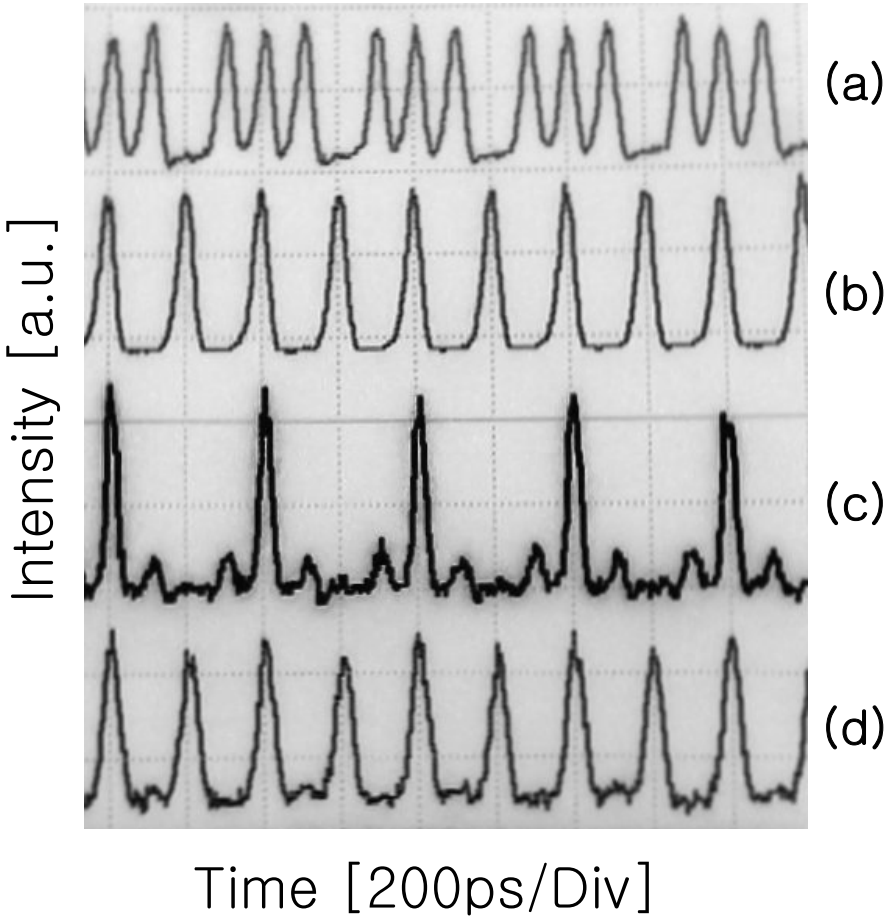
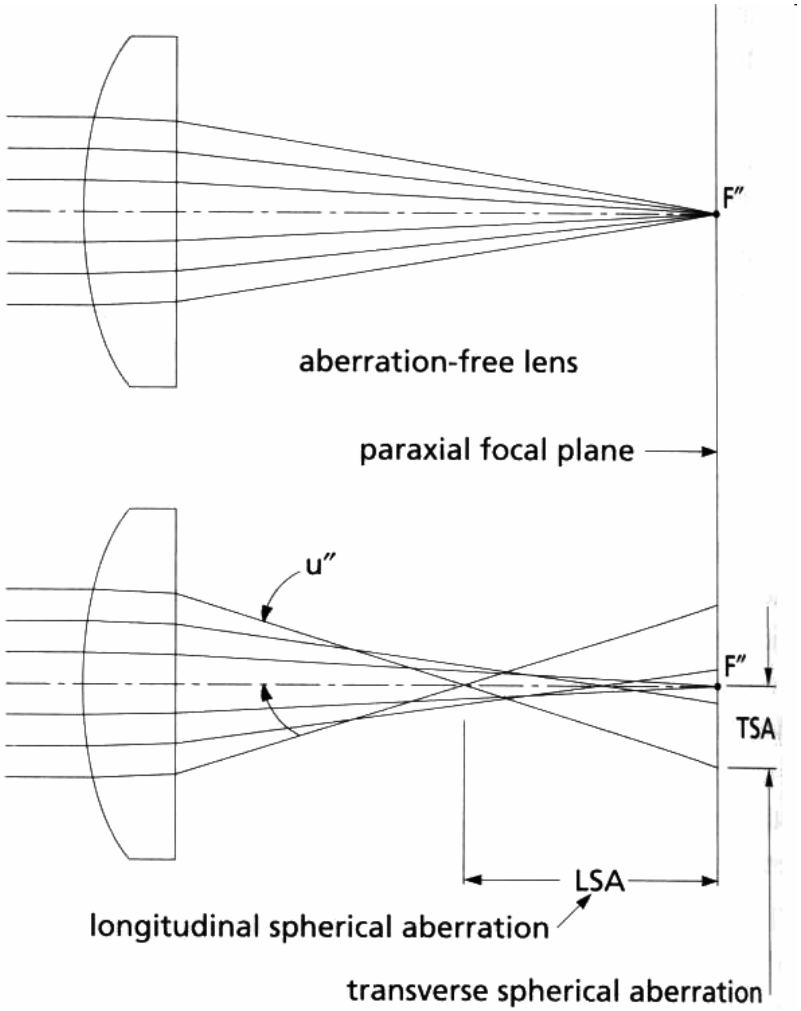


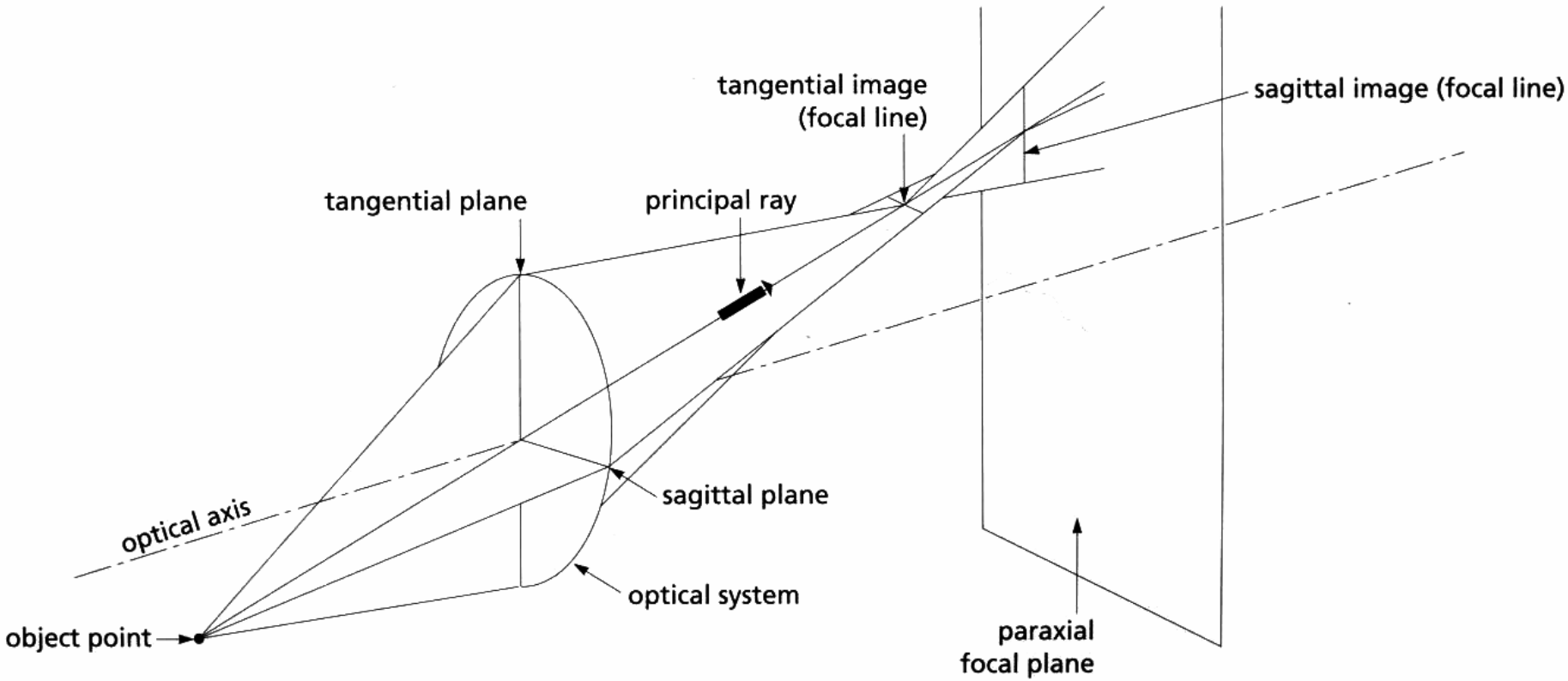


(a) 10Gbit/s serial input data
(b) Parallel input clock for D_1
(c) 5Gbit/s converted parallel output data D_1
(d) 5Gbit/s converted parallel output data D_2

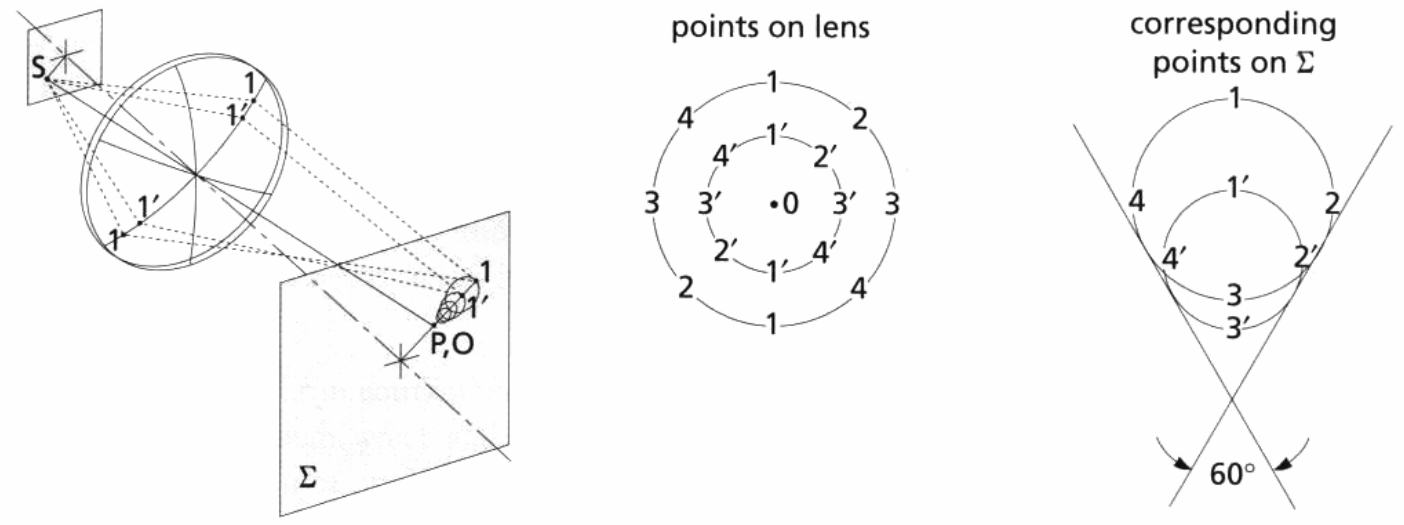
Spherical Aberration

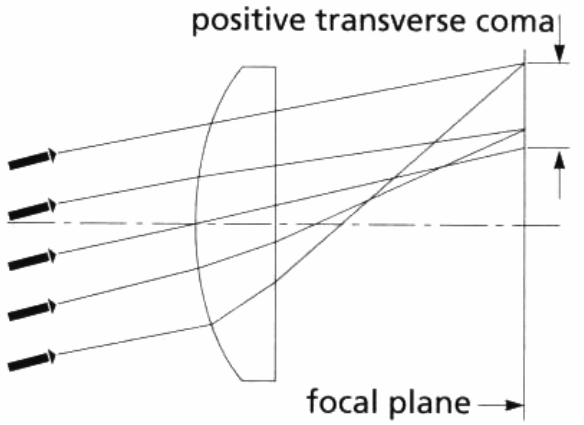


Astigmatism



Coma


S
1
1′
1′
1
1
1′
P,O
Σ
points on lens
1
2
3
4
1′
2′
3′
4′
•0
corresponding
points on Σ
60°


positive transverse coma
focal plane