Tunable Filter based Optical Add/Drop Technology

(TOADM)

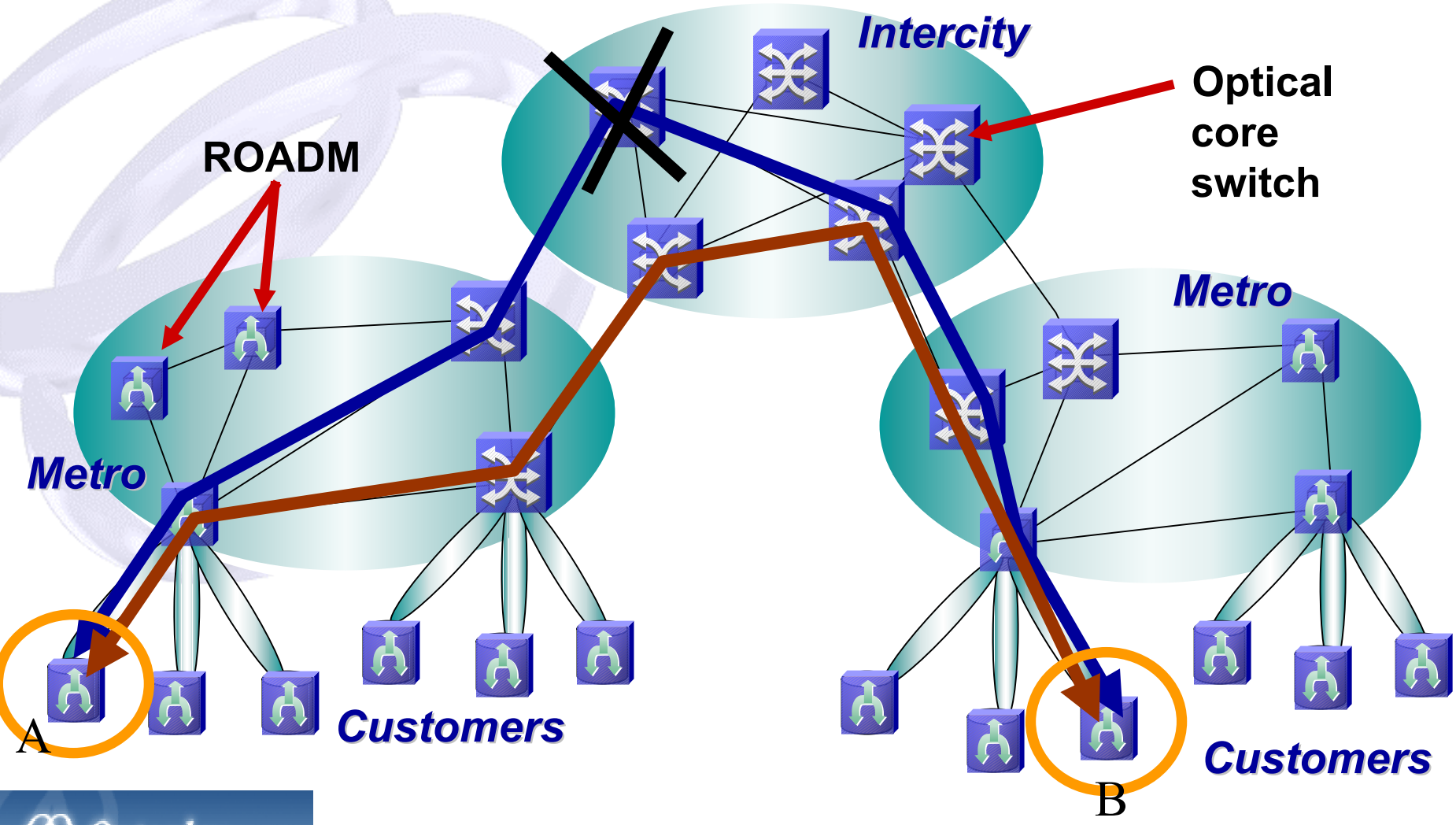
Jay Hsieh, Optoplex Corporation

Fremont, CA

Benefit of Tunability/Reconfig. network

- **Faster and remote provisioning**
- **Bandwidth-on-demand** — Better bandwidth utilization; transform bandwidth capacity to revenue generating services
- **Automated network reconfiguration and restoration** — Flexibility, security and cost-effectiveness

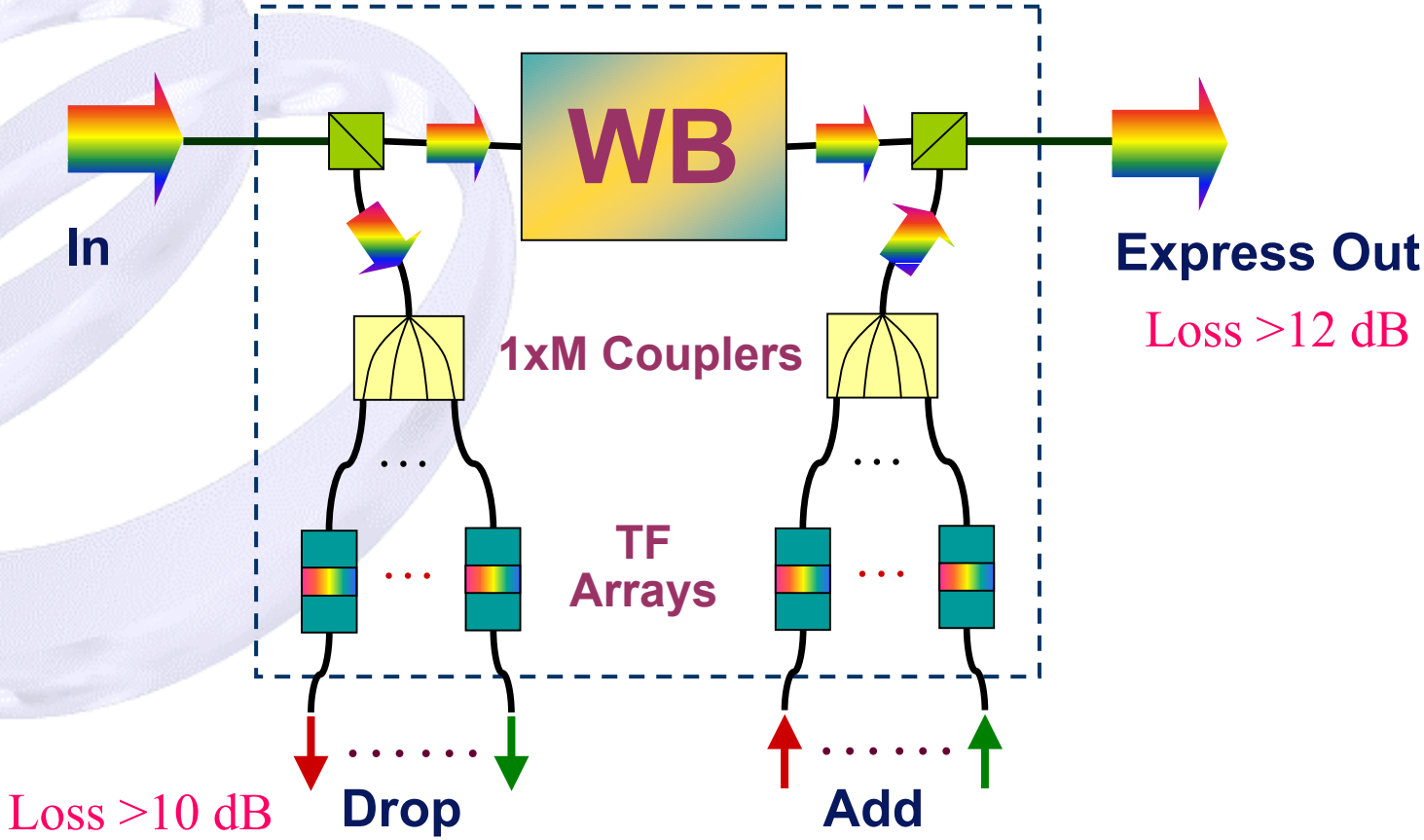
ROADM Optical Networks



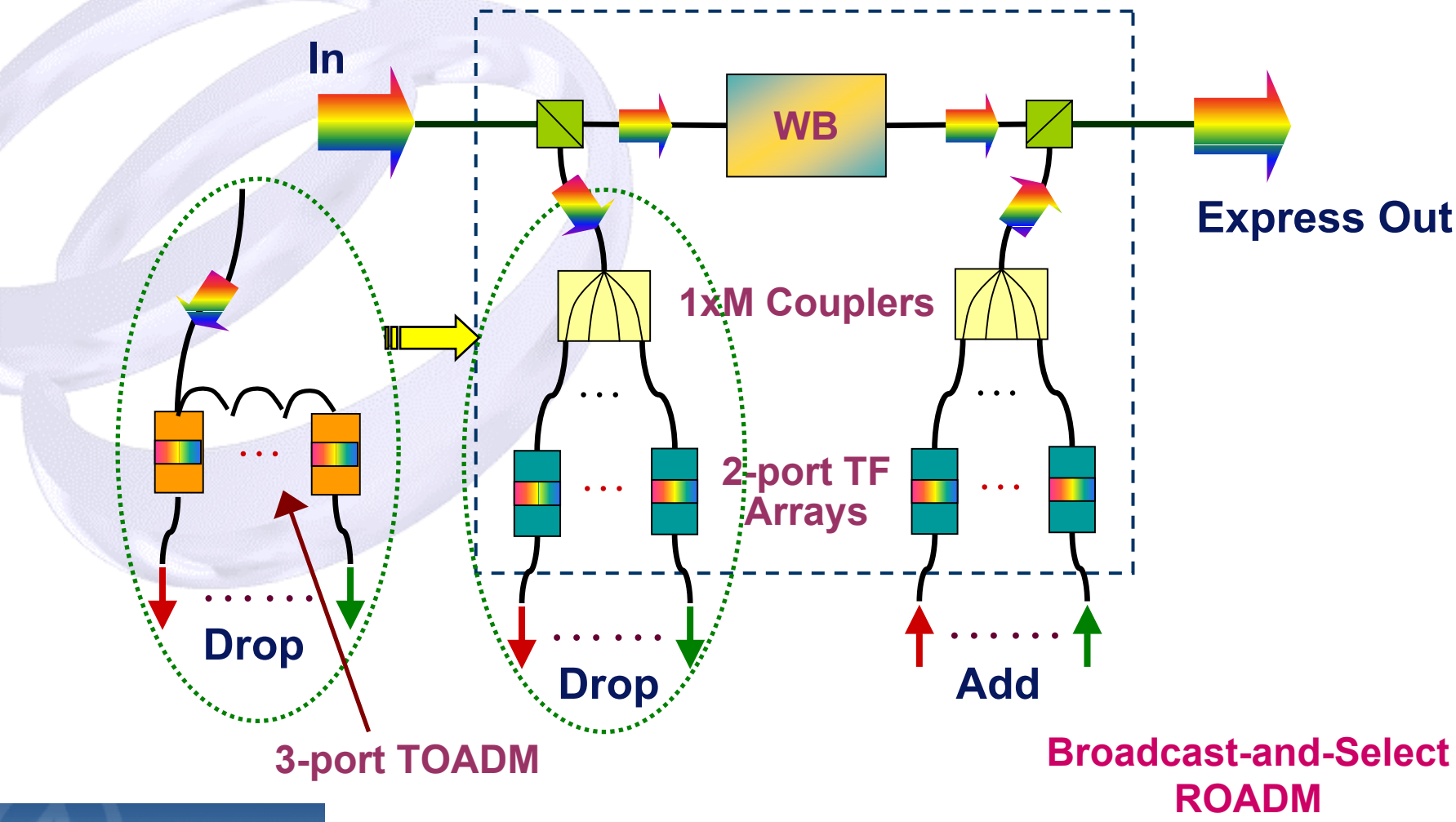
ROADM Technologies

- WB (wavelength blocker) + 2-port tunable filter
- WSS (wavelength selective switch)
- TOADM (tunable optical add/drop module)
- WSS+ TOADM

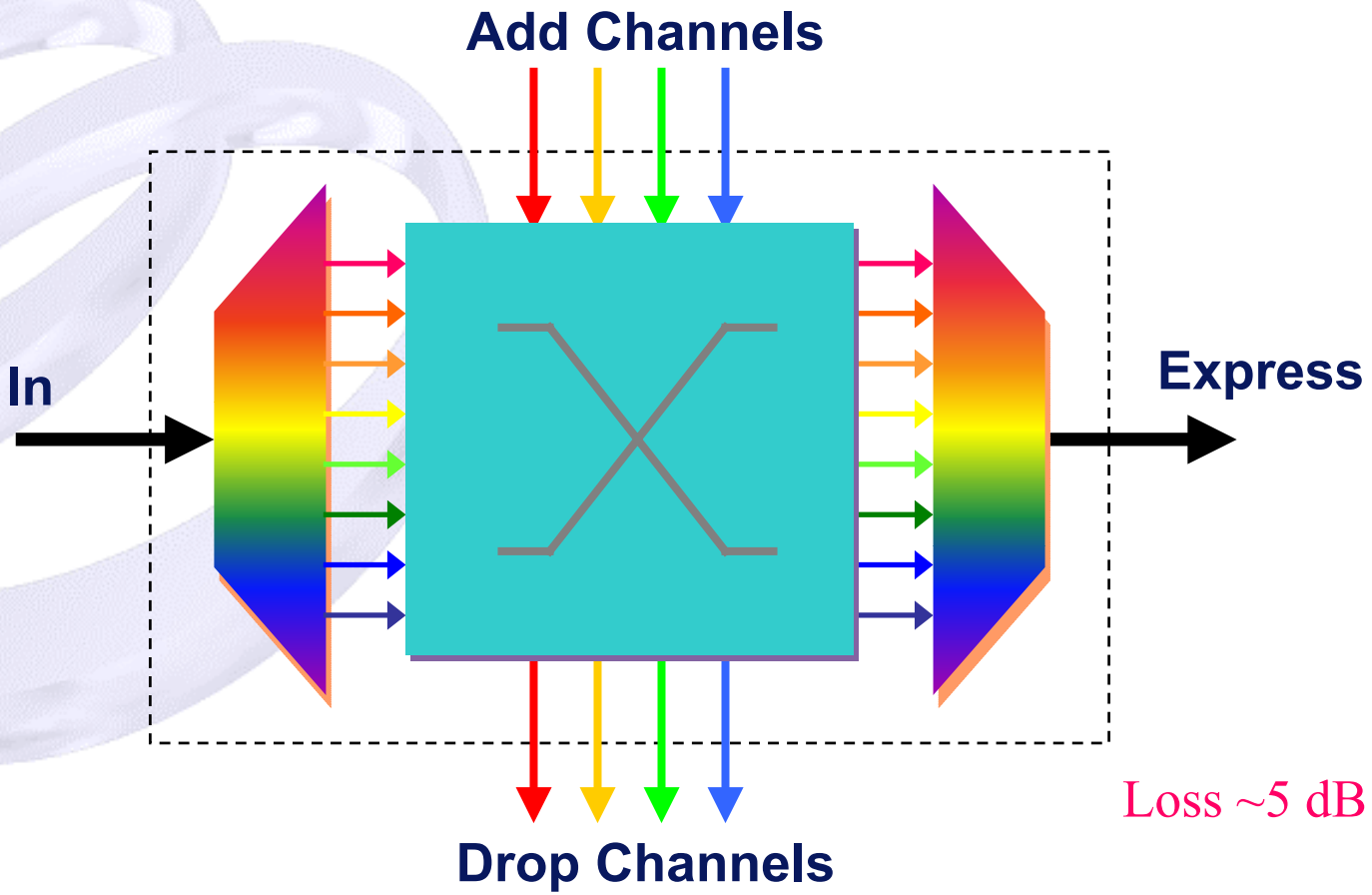
ROADM (1)
(WB + 2-port tunable filters)



Application of TF and TOADM



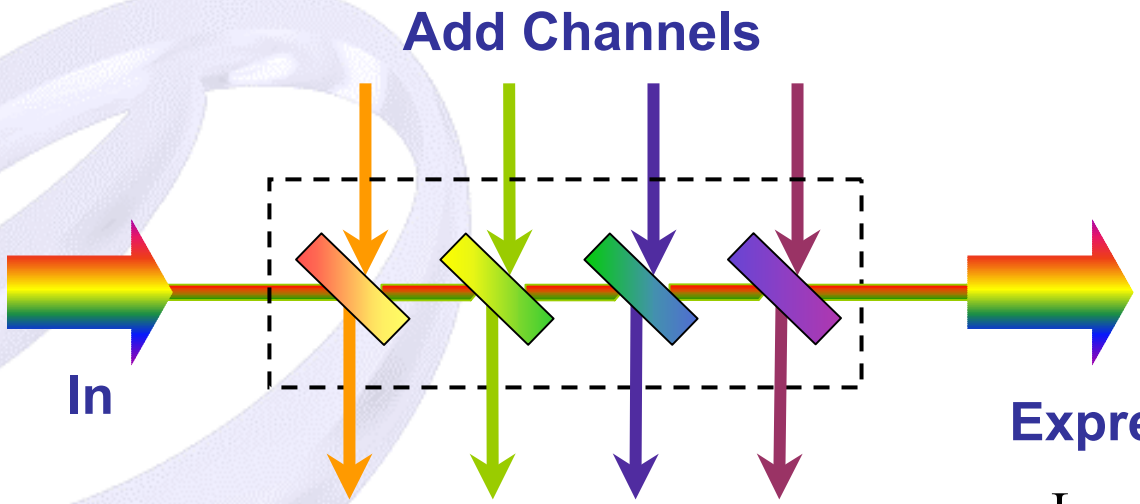
ROADM (2)
Wavelength Selective Switch (WSS)



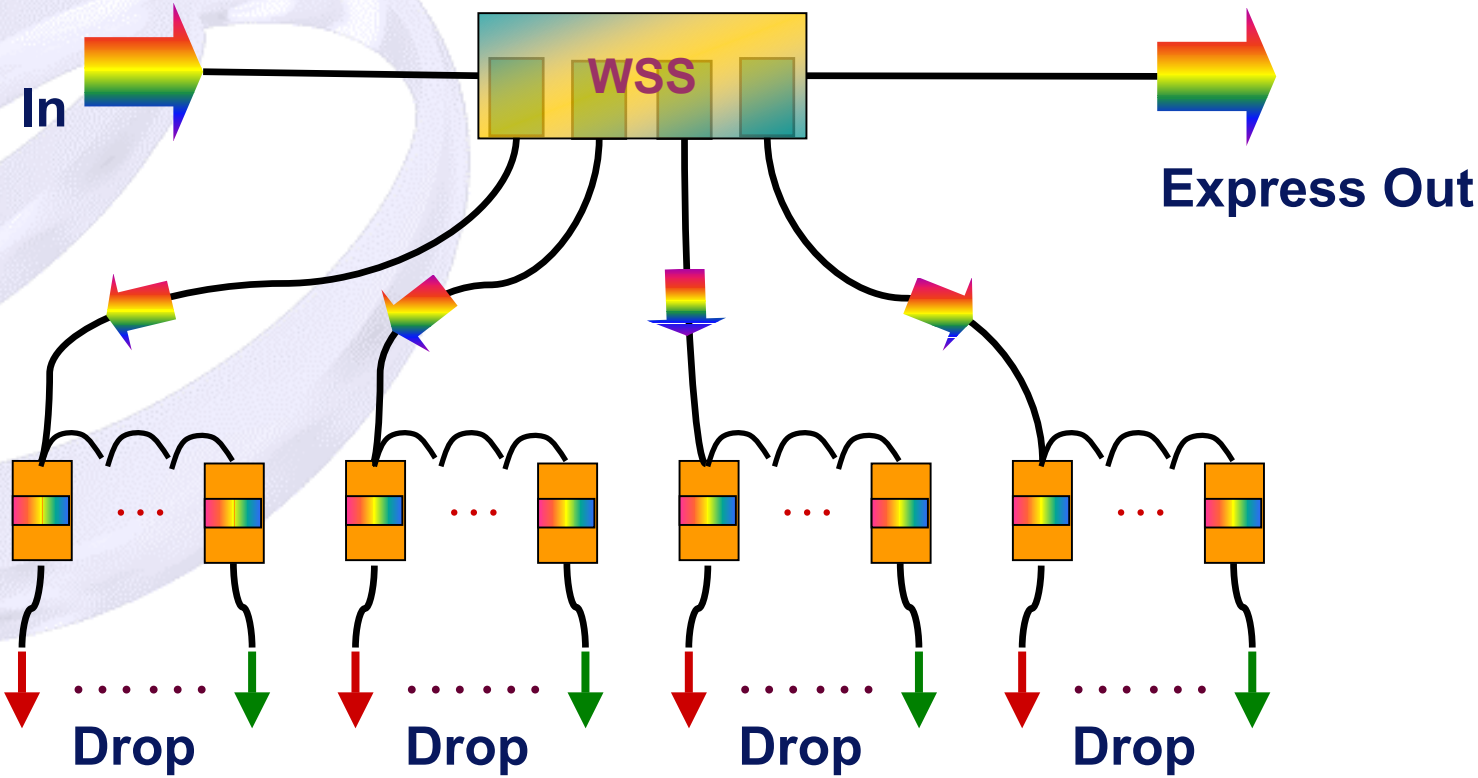
Loss ~5 dB

Grating Demux + MEMS Switchs

ROADM (3)
3-Port Tunable filter(TOADM)



ROADM (4)
WSS + TOADM



WSS re-groups inputs signals into 4 sets
TOADM demux signals in each sub-set

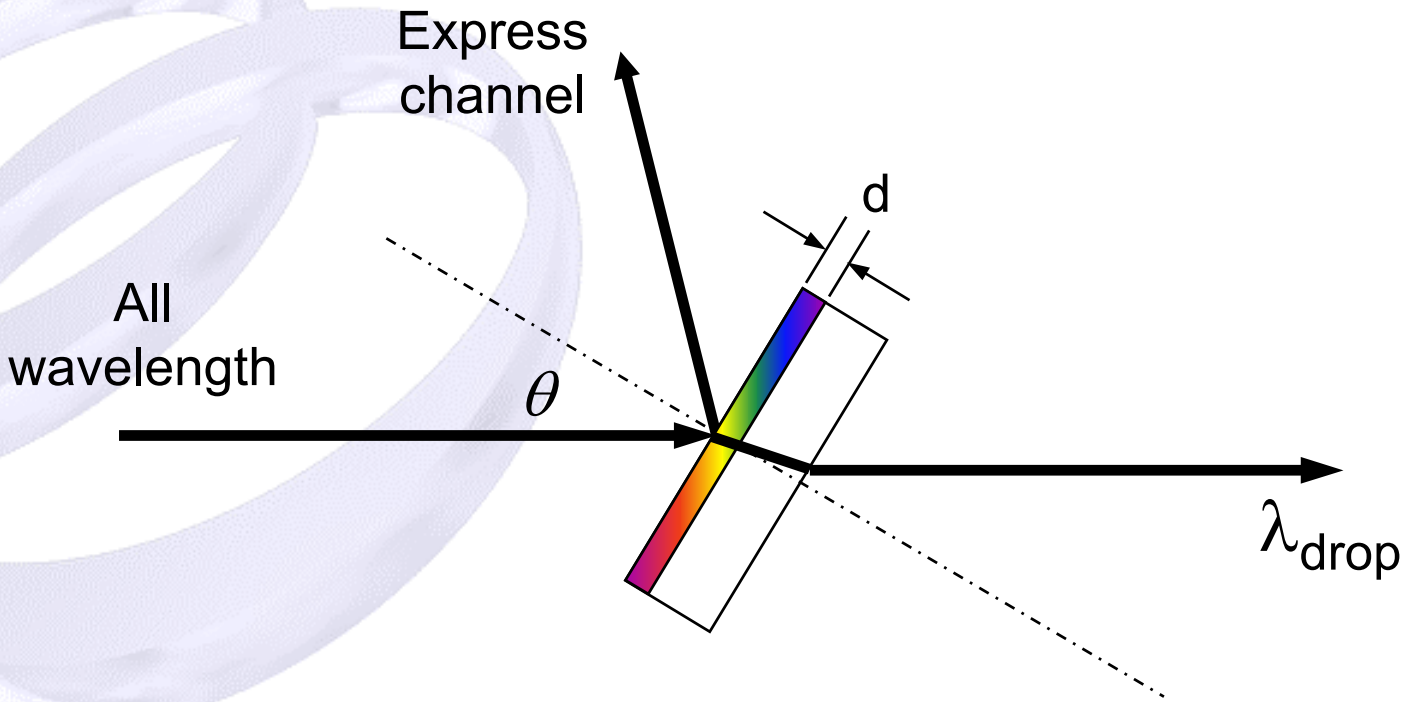
Tunable Filter Technology Comparison

Technology	Passband Flat-top	High Ch. Isolation	Athermal	Latching	3-Port
Single cavity (MEMS Based)	✗	✗	✗	✗	✗
Multi-cavity (Thin-film based)	✓	✓	✓	✓	✓

TOADM

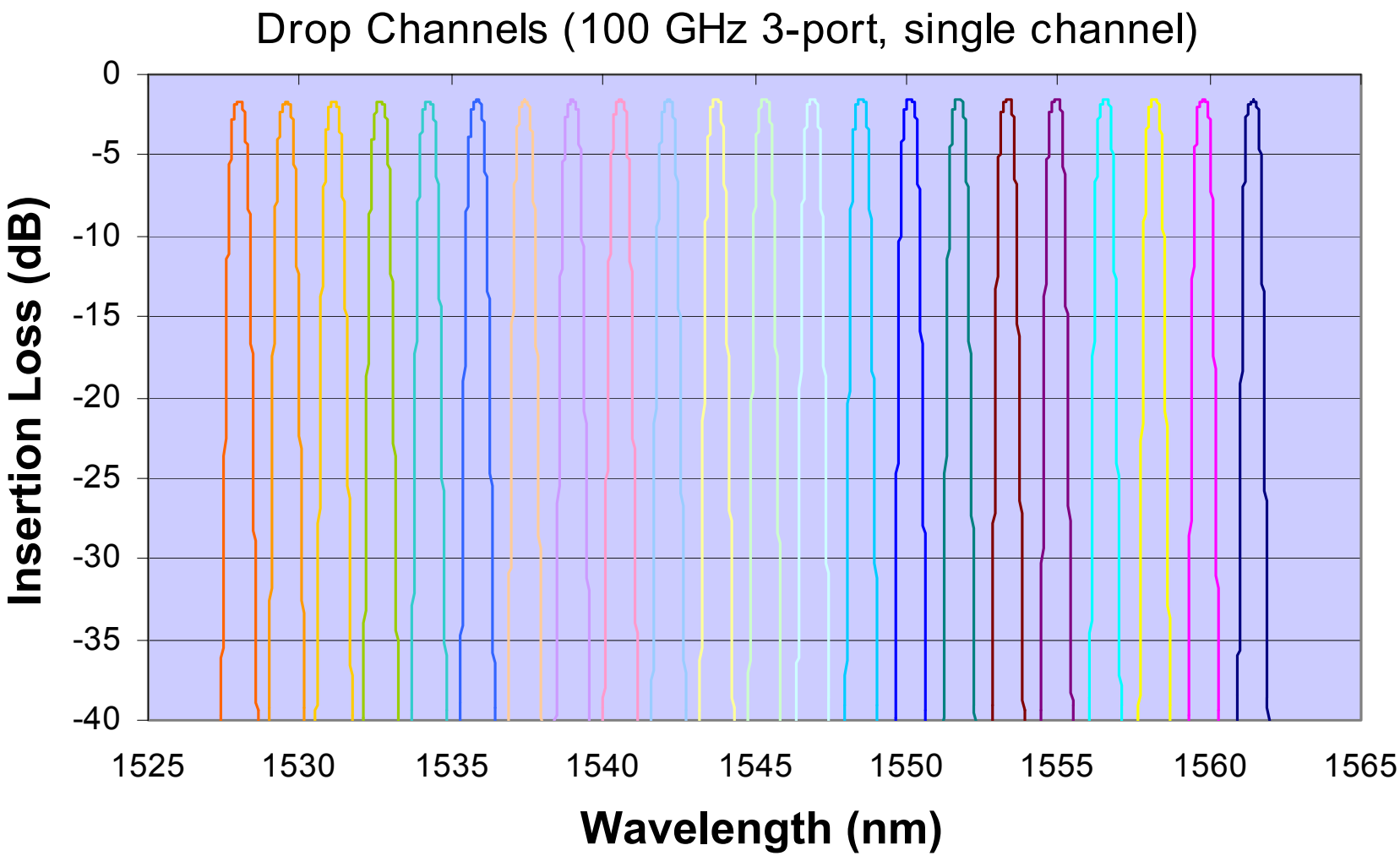
Same size as a credit card

Filter Tuning Mechanism

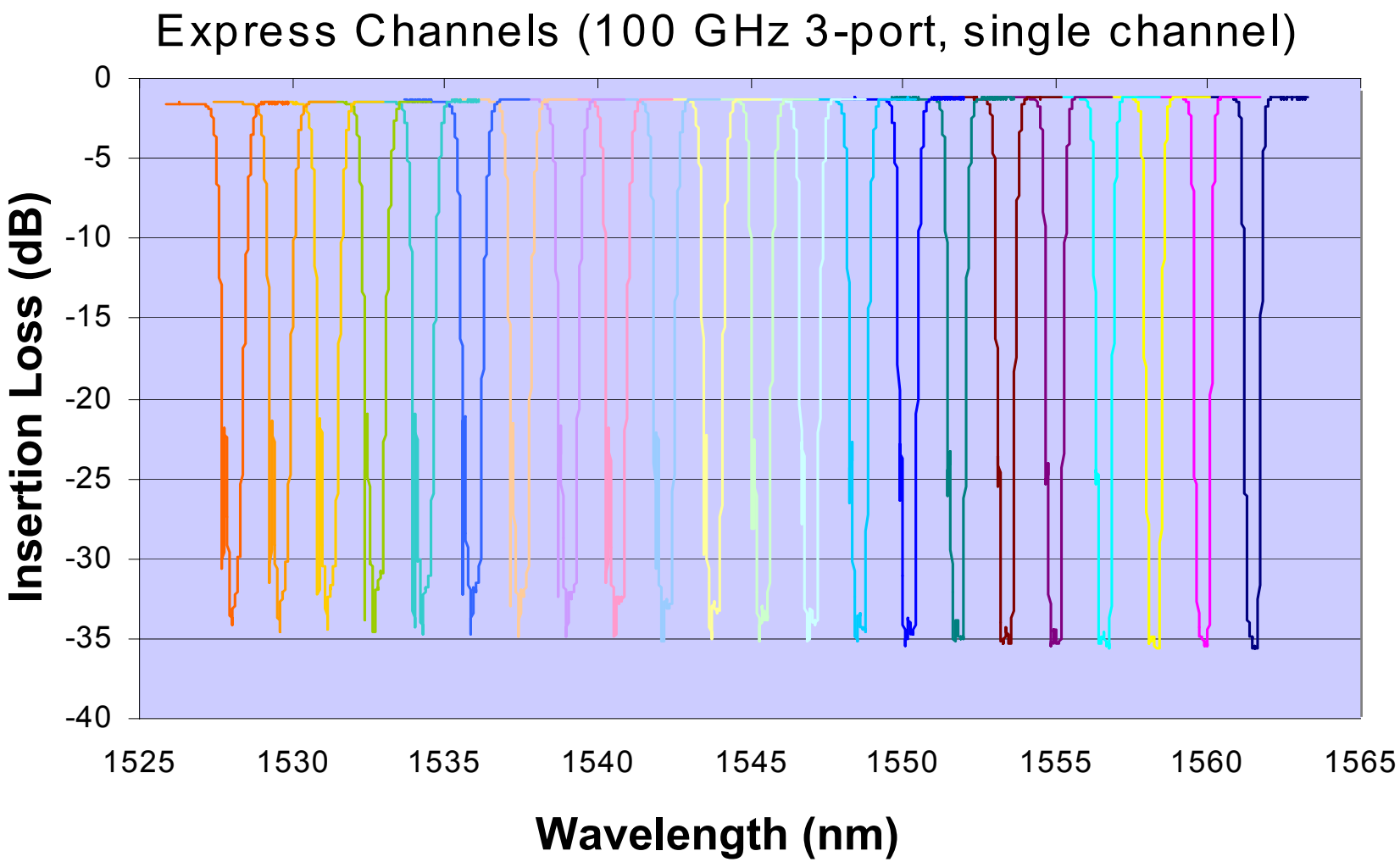


$$\lambda_{drop} = f(n, d, \theta)$$

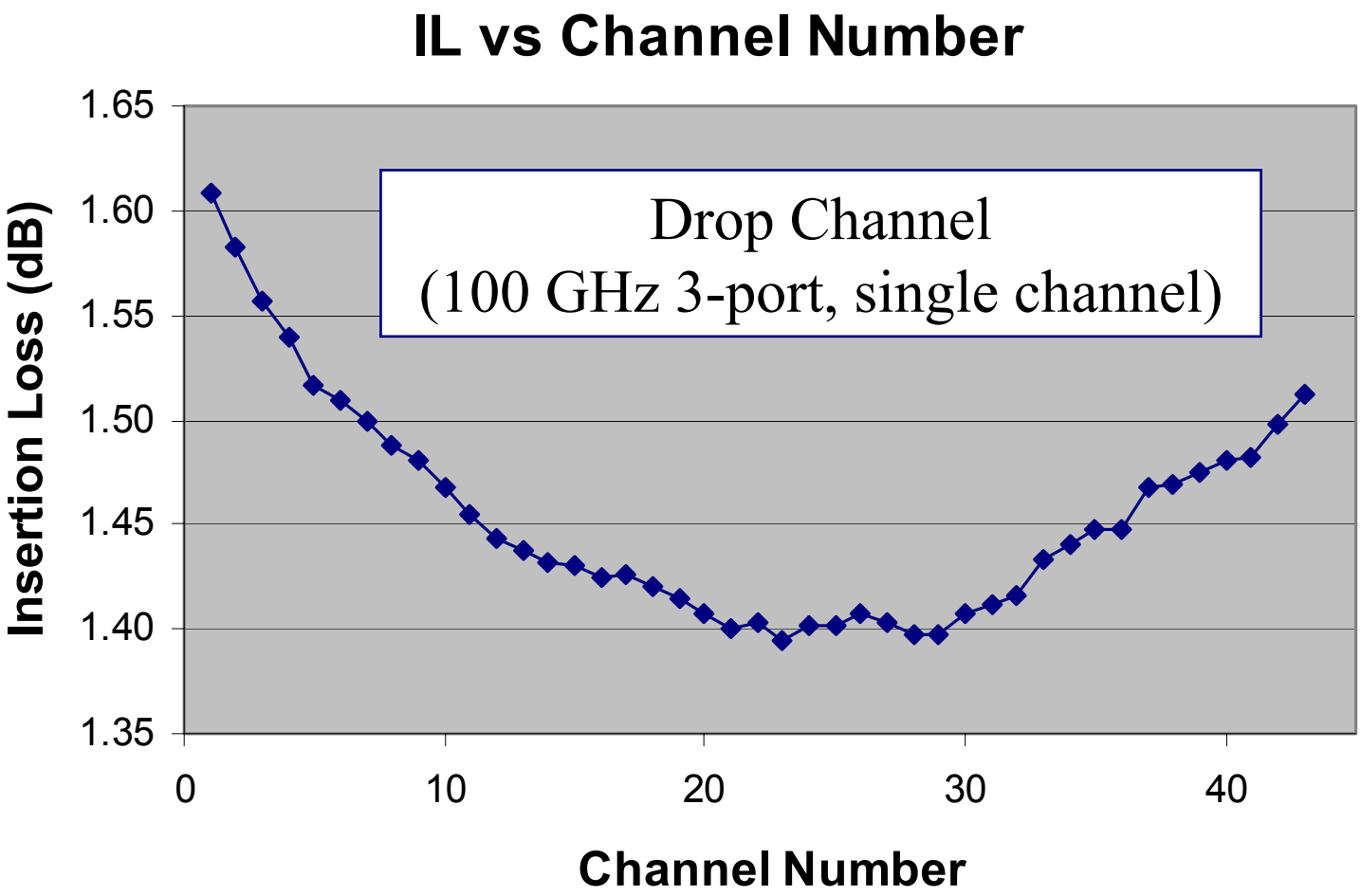
TOADM Performance (1)



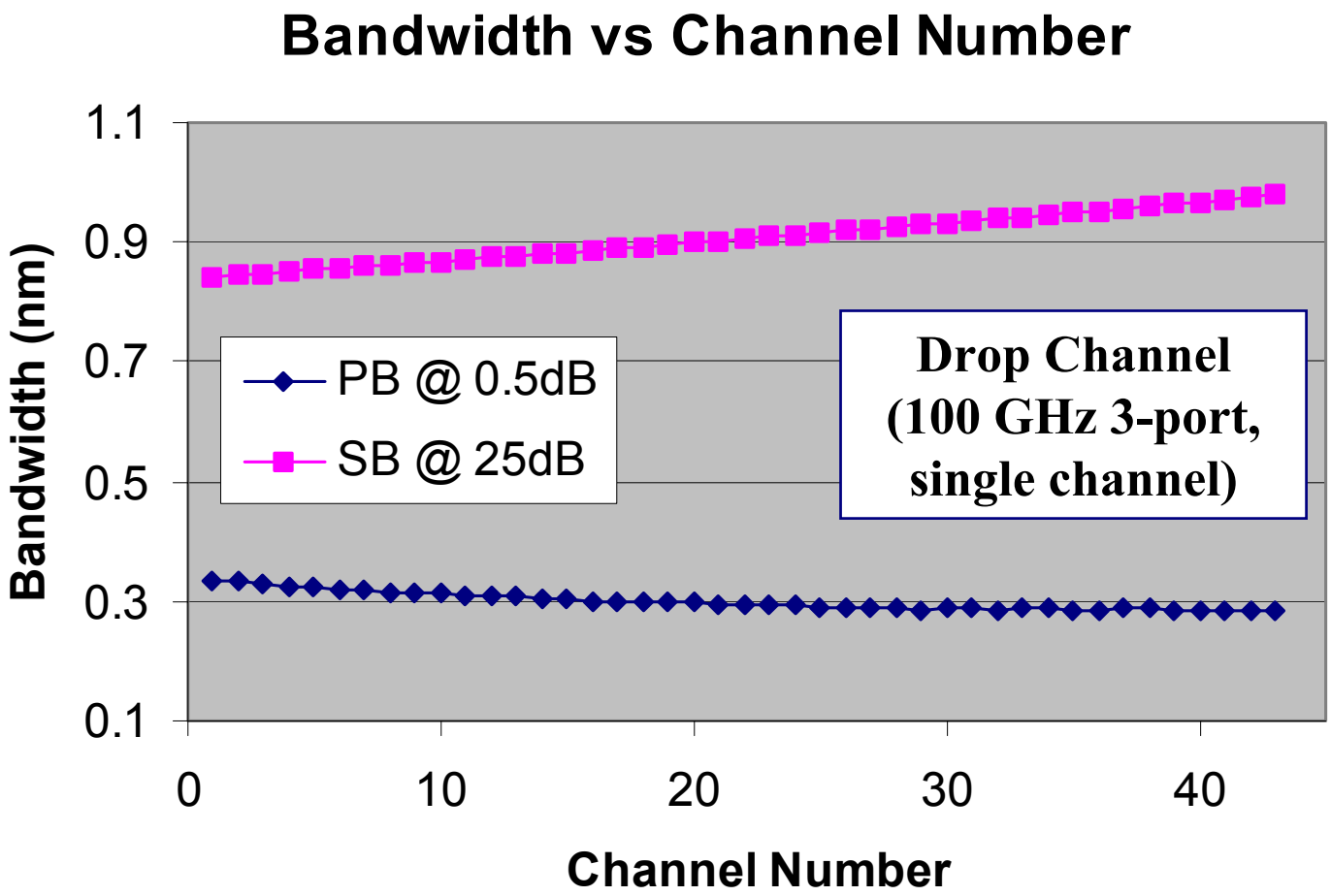
TOADM Performance (2)



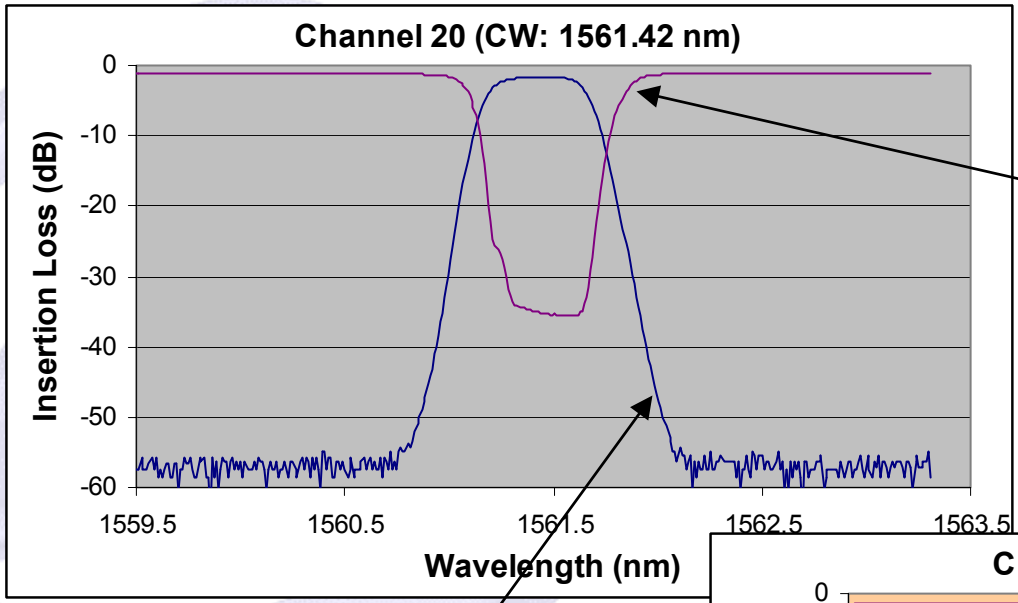
100 GHz Tunable Filter Performance (3)



100 GHz Tunable Filter Performance (4)

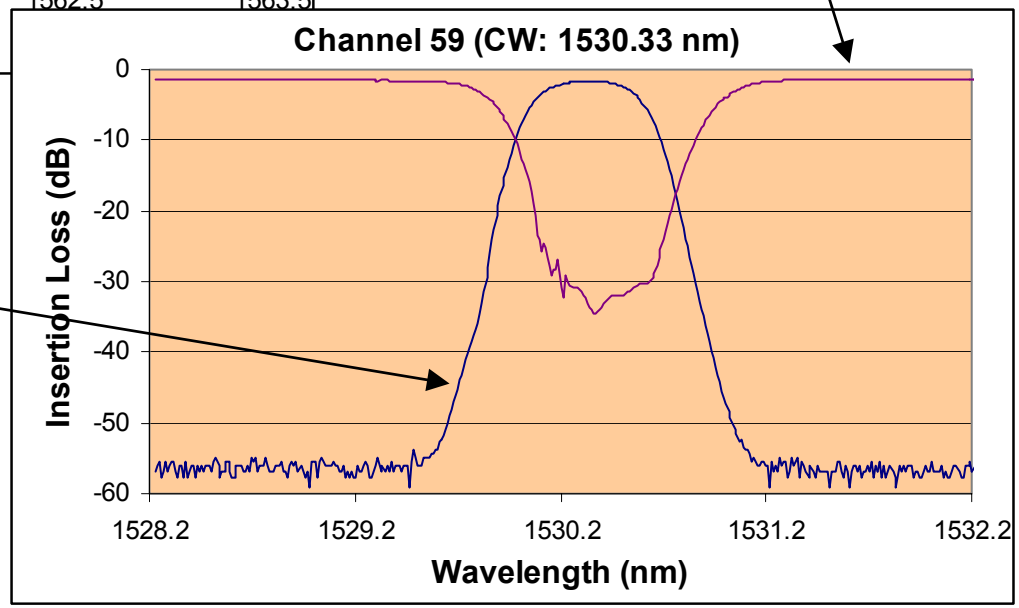


100 GHz Tunable Filter Performance (5) flat top, high isolation



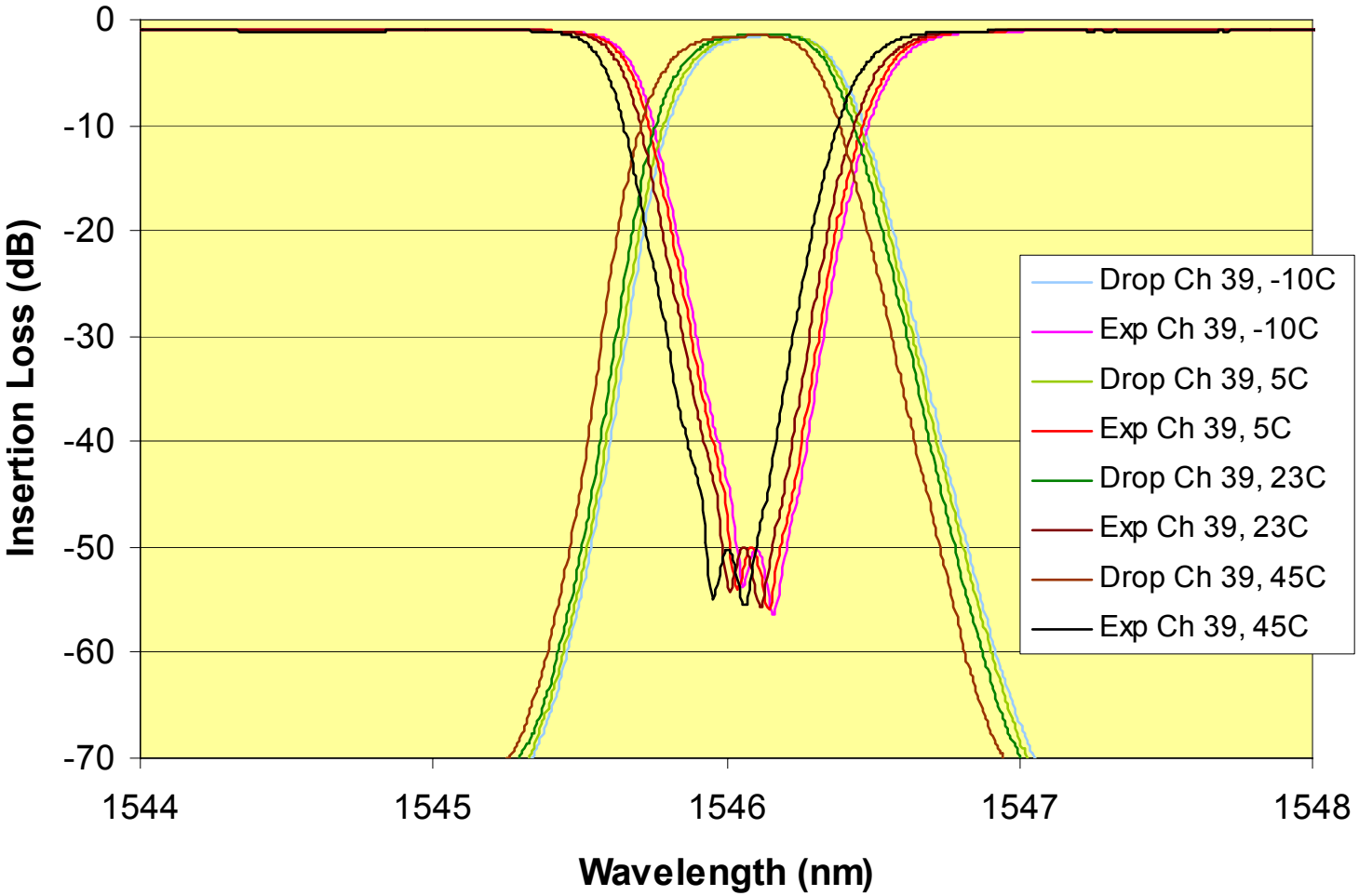
Express Channels

Drop Channels



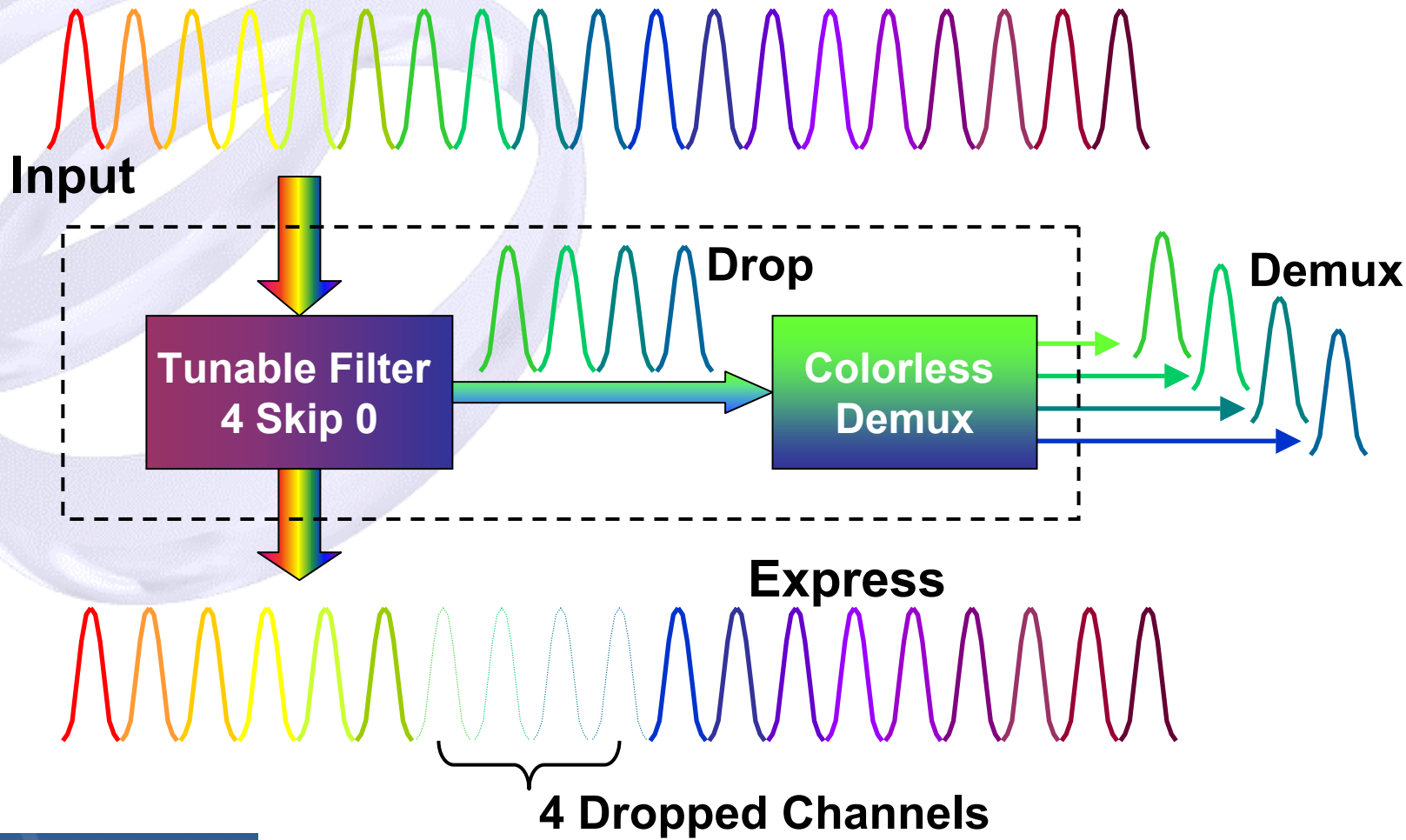
TOADM Performance (6)

performance at various temperatures

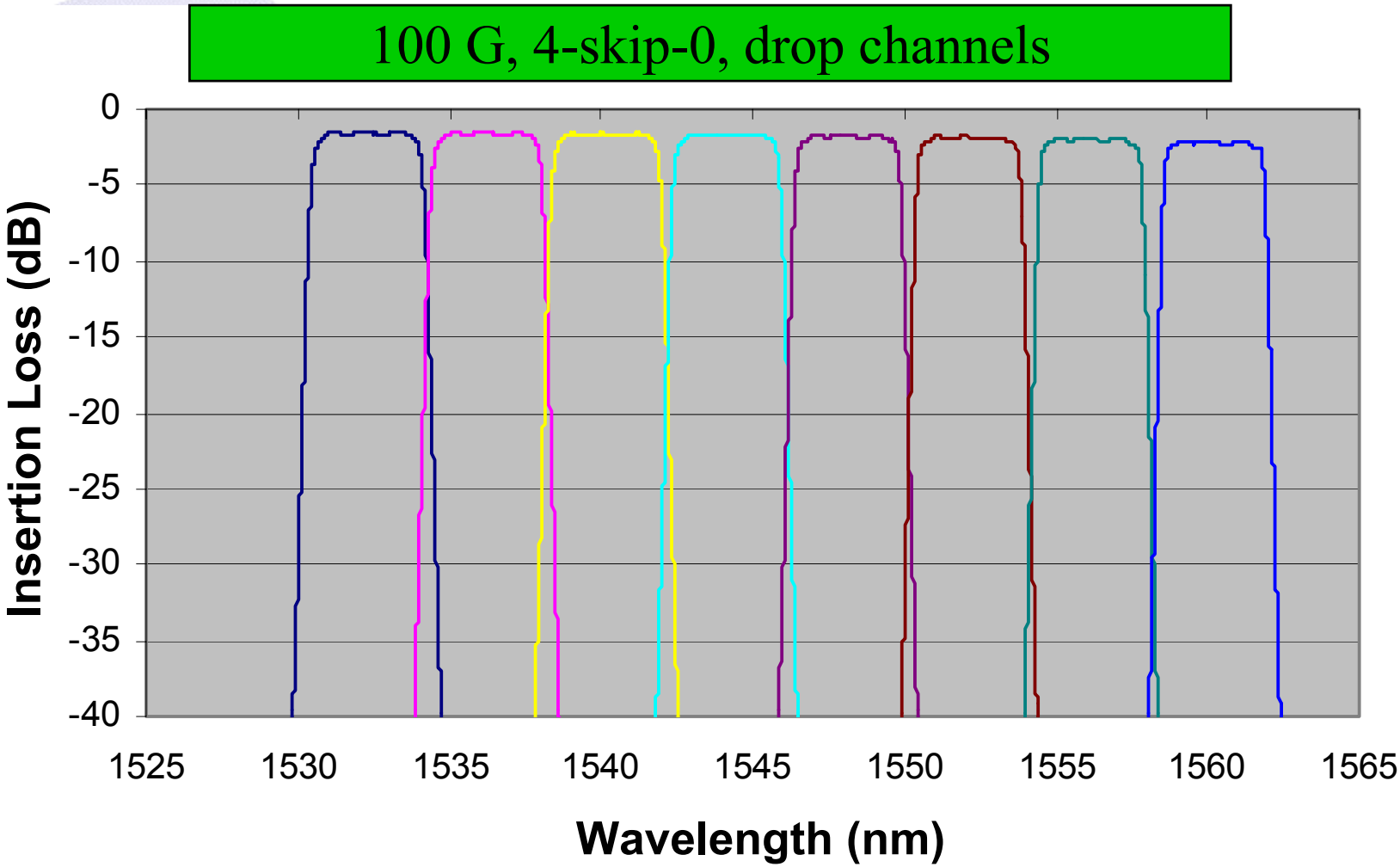


Band-drop TOADM

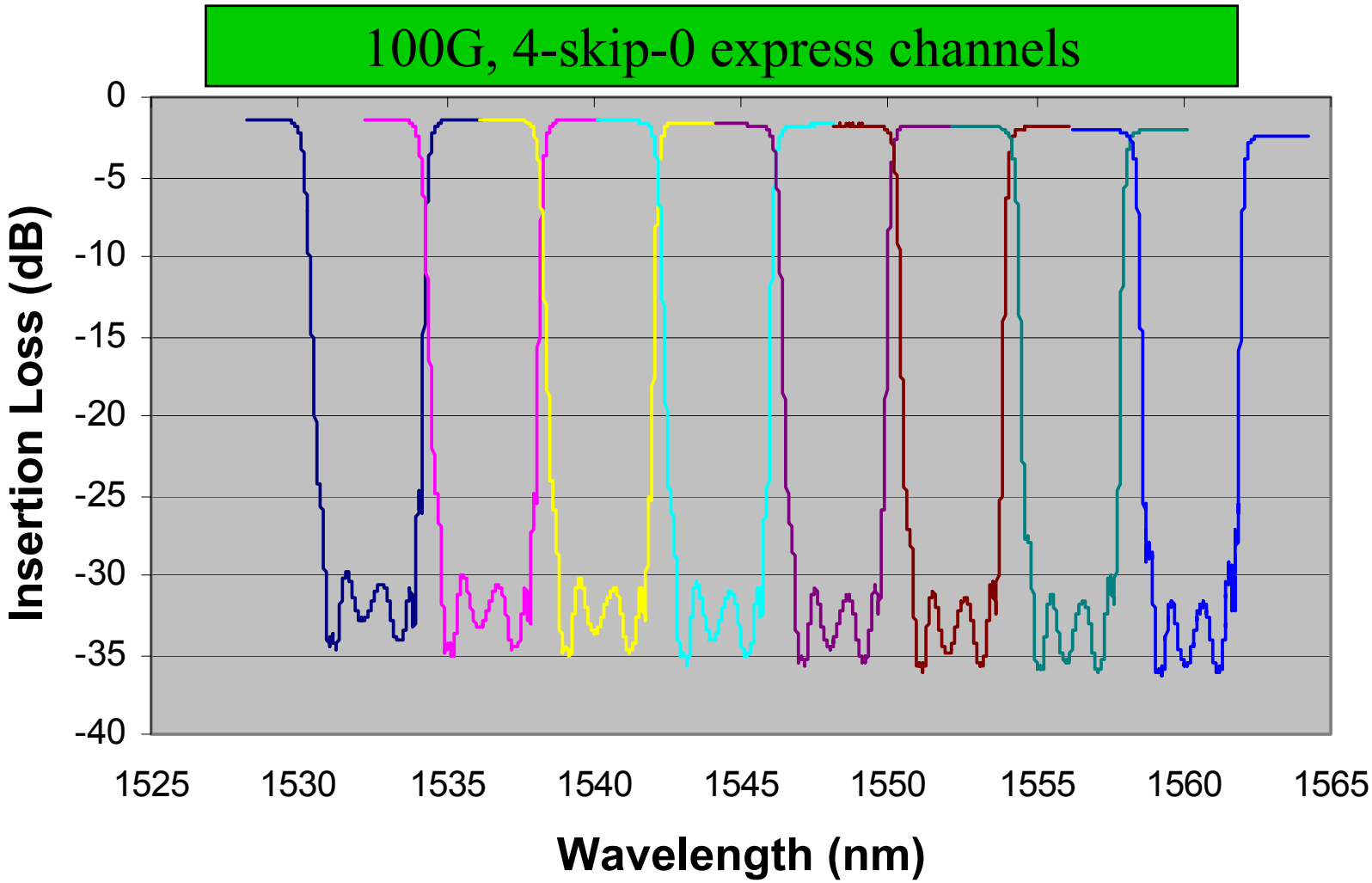
(Band drop TOADM + colorless demux)



Band drop TOADM Performance (1)



Band drop TOADM Performance (2)



Summary

- It has been proved that thin-film based tunable optical add/drop (TOADM) technologies provides a cost-effective, high performance, low technical risk solution for building a reconfigurable optical network.